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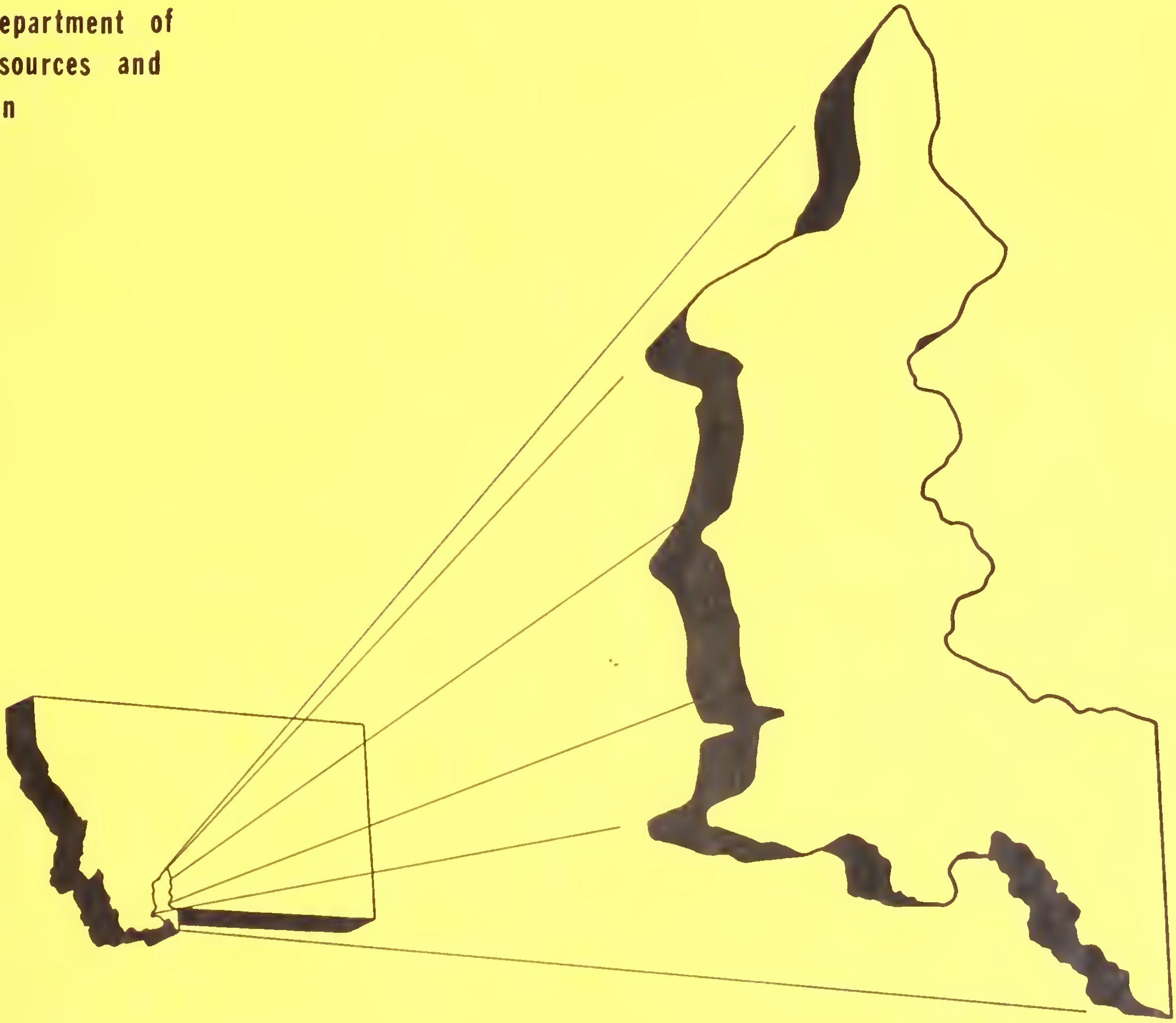
The Madison River Basin

A Resource Review

Prepared by:

The Water Resources Division

Montana Department of
Natural Resources and
Conservation



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INTRODUCTION

The Madison River Resource Review Study was initiated in July 1972 by the Montana Department of Natural Resources and Conservation. This report, when combined with similar data gathered for the rest of the state, will provide the necessary background data for the development of a state water plan. The overall objective of the state water plan is to formulate a progressive program for the conservation, development and utilization of Montana's water resources for the maximum economic and social prosperity of its citizens.

Another objective of this report, along with presenting some state-generated data, is to show the range of available alternatives that the local residents would like to have considered pertaining to future management patterns in the Basin.

It is also anticipated that this report will serve as an informational source to all federal, state, local, and private entities engaged in resource planning and/or management in the Basin.

This report should not be considered a plan for the resources of the Madison Valley. It is, as its title implies, only a survey of the water and related resources of the Basin. The one major conclusion derived is that, before any management alternative is presented for adoption, detailed feasibility studies should be conducted, all necessary data generated, and the public desires considered.

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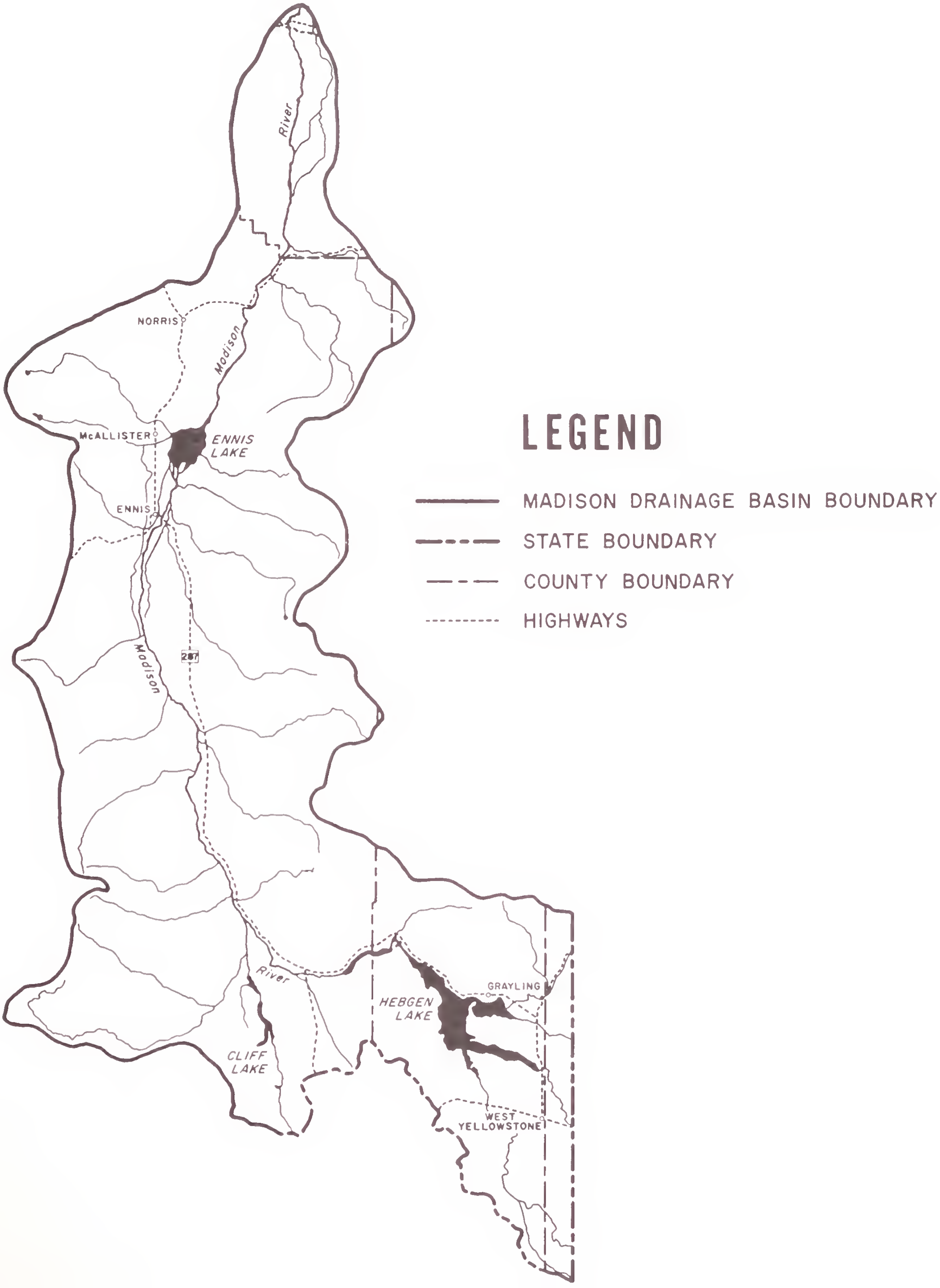
MADISON RIVER BASIN - MONTANA



PHYSICAL CHARACTERISTICS AND RESOURCES

Climate

The climate of the area, similar to that of other intermountain valleys of the northwest, is characterized by comparatively low rainfall, great extremes of temperature, a high proportion of sunny days and low humidity. High summer temperatures are not oppressive because of the low humidity. Nights are usually cool.

Because the population is largely confined to the valleys, long-term weather records are not available for much of the mountain area. In the valleys, precipitation reaches a peak in May and June with a minor peak in September. The driest months of the year are, inclusively, November through February. Precipitation is the heaviest on the western or windward slope of the mountains. At Ennis, in the center of the Madison Valley, the average annual precipitation is 11.14 inches, but at the Norris-Madison Powerhouse, which is ten miles NNE in the foothills of the Madison Range, the average annual precipitation is 17.46 inches. In the mountains winter snow is heavy and does not melt off until late spring or early summer.

During the spring months skies are often cloudy, and there are frequent periods of showers or general rains. During the summer and fall months there are long periods of clear, sunny weather interrupted only by short periods of showers. Inflows of cold arctic air during the winter months sometimes bring below zero temperatures for several days at a time. Blowing snow and blizzard-like conditions sometimes accompany these cold periods, which are generally not of long duration.

The growing season is short with an average of only 101 days at Ennis and 137 days at the Norris-Madison Powerhouse. Generally freezing temperatures have occurred as late in the spring as mid-June and as early in the fall as the first week of September.

Topography and Drainage

Wide differences in elevation occur between the bottom lands, the higher benches and foothills, and the surrounding mountain peaks in the district. The lowest elevation is approximately 4,315 feet above sea level near Three Forks with the highest point being 11,316 feet on Hilgard Peak near the south end of the Madison Range.

The Basin is parted north of McAllister by a rolling divide with an average elevation of 6,000 feet. The northern portion of the Basin is a complex of rolling uplands and bench remnants. The Madison River Valley south of McAllister lies between the Madison Range on the east and the Gravelly and Tobacco Root

Ranges on the west.

The Madison Valley is an elongated intermountain basin extending southward from Ennis Lake for about fifty miles and averaging four to twelve miles in width. The higher bench terraces lie 150 feet or more above the level of the river. Outwash fans from the mountains form steep, uniform slopes and rise 500 to 1,000 feet above the terraces along the river.

The Madison River bisects the Basin and flows from south to north. Its tributaries drain the west slopes of the Madison Range, the east slopes of the Gravelly Range and the southerly portion of the Tobacco Root Range.

Soils

The wide differences in elevation are reflected in climatic change. This, in turn, affects the biotic influences of soil formation, which give rise to the variation of soils found in the Basin. Soil development has occurred under the influence of rather cold winter and warm summer temperatures with a wide range in annual precipitation. The drier portion of the study area, with an average annual precipitation of 10 to 12 inches, lies in the middle of the Madison Valley. At the higher elevations, in the forested soil areas of the mountains, the annual precipitation may exceed 30 inches.

Most of the soils in the Basin occupy the stream valleys and upland terraces with calcareous silt loam and clay loam textures predominating. The effective soil depth to underlying beds of sand and gravel in the stream valleys or to bedrock in the residual uplands is quite variable and will range from a few inches to several feet in thickness. Extensive areas of loess occupy the intermediate terraces, which lie between the alluvial deposits of the bottom lands and the highest terraces of the uplands in the northern part of the Basin. These loess deposits also occur next to the mountains in the Madison Valley and cap the alluvial deposits at variable depths. The different kinds of soils found in the area can best be discussed by relating them to the kind of landscape on which they commonly occur. The can be readily identified by the following physiographic position they occupy.

1. Recent alluvial deposits of the low river terraces, bottom lands and flood plains. This will include some small alluvial fans.

> The recent alluvial soils that occupy the low river terraces, bottom lands and flood plains are probably the most variable as to their character, size of area and pattern. This is due to the continuous alteration these soils are subjected to by stream dissection, flooding, deposition and erosion.
>
> Soil textures vary from sand to clay and range from a few inches to five feet or more in depth to beds of sand and gravel. They are both

light and dark in color. They may be imperfectly to poorly drained, with the exception of some of the shallow soils underlain by gravel, where water tables recede rapidly as the streams subside. Most of the saline-alkaline soils found in the Basin are associated with these soils. The expanse of an individual kind of soil commonly found in this type of landscape seldom exceeds twenty acres and frequently is less than two or three acres in size. The soils occur in irregular patterns, and fields larger than ten acres will usually have two or more kinds of soil.

These soils are utilized primarily for hay and pasture. However, some of the shallow soils being irrigated and some of the deeper soils that are artificially drained are being used for the production of small grain.

2. Well-drained soils of the intermediate and high bench terraces, foot slopes and older alluvial fans.

The well-drained soils of the intermediate and high bench terraces are the most extensive in the Basin and are utilized primarily for native pasture with some irrigated crop production. They are much less variable than the recent alluvial deposits and occur in rather large areas. The soils are seldom more than 36 inches deep and often less than 20 inches in depth. They are predominately of loam or gravelly loam texture. Many of the terraces are underlain by beds of sand and gravel at shallow depths. Some of these soils are quite gravelly or cobbly and will contain 20% to 50% gravel and/or cobble in the profile. In the vicinity of the Madison River these soils are light in color, but, as the elevation increases, they become dark brown or nearly black. This indicates an increase of 3 to 5 inches or more in annual precipitation above that occurring along the river. The darker soil color is also indicative of higher organic matter content.

3. Steep, dissected terrace edges and drainages.

The soils on the steep, dissected terrace edges and drainages are used primarily for native pasture due to the hazard of increased erosion if cultivated. They are quite variable in depth, and some areas contain considerable amounts of gravel, cobble and stone. Soil textures range from clay loam to sandy loam, with some stony loams.

4. Residual soils of the rolling, hilly and steep mountainous lands.

The different kinds of soils occurring on the residual rolling hills and steep mountainous slopes are influenced by the many different types of parent material from which they have weathered. In these areas elevation differences are greatest, and this, in turn, influences the kind of climatic and biotic forces affecting soil formation as well as soil erosion. The soils of the grassland region, which vary considerably in depth, texture and color, have occasional to numerous rock outcrops of varied and mixed lithology. The deeper soils generally occur in the swales, foot slopes and concave position where loess and alluvium deposits have contributed to the soil depth.

The differences in soil textures, which range from sandy loam to clay, can be partially attributed to the parent rock from which they have weathered. Where it occurs, the loess mantle, which varies in depth from a few inches to several feet, is a silt loam or fine sandy loam texture. Some of the larger and deeper loess mantles are being used for cropland. The soil at the drier, lower elevations is light in color and calcareous at or near the surface. At the higher elevations, the surface soil is nearly black and usually leached of lime to depths greater than 15 inches. The forested soil areas are of limited extent and occur at higher elevations with cooler temperatures and in areas of more precipitation. Soil depth and texture vary considerably in the forested areas, but a light gray soil surface beneath a thin forest litter is characteristic.

Soils of glacial origin are of limited importance and occur primarily in the mountain stream valleys and at the mouths of tributary canyons.

Native Vegetation

With abrupt changes of elevation come abrupt changes of vegetation. Above the 9,500 foot level vegetation is limited to Lichens with a few soil pockets growing Beargrass and Sedges. These areas are as native as they were before man settled the valleys.

The next lower belt of vegetation is the coniferous forest, consisting of Whitebark Pine, Limber Pine, Alpine Fir and Spruce. Various shrubs such as Whortleberry, Blueberry, Oregon Grape and Bearberry are also found. Beargrass, Pinegrass, Sedges, Arnicas and Mountain Heather form the understory. Although these areas are lightly grazed by sheep, they furnish only small amounts of forage.

The next lower belt of vegetation consists of the coniferous forest with open grasslands. Lodgepole Pine and the Douglas Fir stands are intermixed with open grassland and some meadows. The understory, mainly Arnica and Pinegrass, is sparce in the Lodgepole Pine stands, but the older Douglas Fir stands permit much more understory. The main grasslands are generally composed of Idaho fescue, Columbia needlegrass, Slender wheatgrass, Bearded wheatgrass, Timber oatgrass, Sedges, Mountain brome and Rough fescue. The forbs are Lupine, Geraniums, Cinquefoil, Paintbrushes and Larkspurs. This belt is the main sheep range of the National Forest lands.

As range condition deteriorates on the above lands, mountain brome and wheatgrass species decrease while Sagebrush, Lupine and Idaho fescue predominate. Rough fescue and Spike fescue have practically disappeared in this zone and are found only in scattered remnants. The vegetation within the area described is in the 20 to 24 inch rainfall belt.

The next lower zone, which has scattered blocks of open Douglas Fir with Lodgepole Pine, Aspen and Willows, mostly consists of open grasslands. Bluebunch wheatgrass, Basin wildrye, Idaho fescue, Bearded wheatgrass, Spike fescue, Green needlegrass and Richardson needlegrass are the primary forage plants with small amounts of Sandberg bluegrass and Junegrass. As range conditions are lowered, Big Sagebrush, Threetip Sagebrush, Rubber Rabbitbrush and other undesirable plants take over the area. The taller wheatgrasses and Green needlegrass may stay alive in the sagebrush clumps. Idaho fescue, Lupine, Western Yarrow and Sandberg bluegrass, Shrubby cinquefoil, Sedges, Goldenpea and Iris dominate the overgrazed areas where there is subirrigation.

Most of the last described lands are in the National Forest and are administered by the Forest Service. However, some of these lands as well as lands in the 20 to 24 inch rainfall belt are privately owned and outside the National Forest boundaries.

The next lower belt is bench land and lower foothills. The major species here include Bluebunch wheatgrass, Green needlegrass, Indian ricegrass, Western wheatgrass and Needle-and-Thread grass with some Mountain Mahogany and Rocky Mountain Juniper occupying the rocky outcrop in these areas. Today many of these ranges are nearly solid stands of Needle-and-Thread grass with Blue grama, Sandberg bluegrass, Junegrass and Needleleaf Sedge intermixed with Fringed Sagewort, Broom Snakeweed and Pricklypear.

This zone was unfenced and grazed by vast numbers of horses and sheep during the early history of the area. Half of this range land has improved through good management practices, but the other half is still producing only 30 to 40% of its potential.

Water Resources

There are two major lakes, Hebgen and Ennis, that regulate flows of the Madison River. Hebgen Lake, which was formed by the construction of Hebgen Dam in 1915, is located about eighteen miles northwest of West Yellowstone, Montana. The lake has approximately 386,000 acre feet of conservation or useful storage and 7,300 acre feet of dead storage. Ennis Lake, located about five miles northeast of McAllister, Montana, was completed in 1900 to supply the Madison power plant. It has a usable capacity of 41,000 acre feet and a dead storage capacity of 1,040 acre feet. Waters of both lakes are used primarily for regulation of river flows for power generation and, in recent years, for recreational purposes. Earthquake Lake, formed by the 1959 earthquake, is also located on the Madison River immediately below Hebgen Dam, but it provides very little regulation to flows of the river.

The major tributaries, all of which head high in the mountains, are fed by melting snow and are perennial. High flows of these tributaries, as well as of the Madison River itself, normally occur in May or June as the result of spring runoff from the snow melt and spring rains. Low flows usually occur during the late summer, concurrent with the peak irrigation season, and in the winter or early spring months.

Several irrigation dams have been built on tributary streams to supplement the flows during the summer months. Many of these dams were constructed in the early 1900's and are in need of rehabilitation and repair. There are additional sites on the tributaries where reservoirs could be constructed, and a list of these appears on page 45 of this report.

The following table shows the stream flow records for most of the gaging stations within the Basin. There are several other stations that either have operated in the past or are currently operated on a seasonal basis. Estimates of flow patterns are given for seven of the major tributaries in the water availability section.

TABLE 1 STREAM FLOW RECORDS OF SELECTED STATIONS

Station	Years of Record	Drainage Area (Square Miles)	Average Annual Runoff (cfs) **	Average Annual Runoff (A.F.)***
Gibbon River	1	118	101	72,900
Madison River - West Yellowstone	55	420	482	349,200
Madison River - Grayling	61	905	972	704,200
Madison River - Kirby Ranch - Cameron *	11	1,065	1,378	997,600
W. F. Madison River	2	220	919	66,360
Madison River - Cameron *	13	1,669	1,432	1,037,000
Madison River - McAllister	32	2,186	1,690	1,224,000
Madison River - Three Forks	16	2,511	1,650	1,197,900

* These are different stations. In the past gages were named after the nearest post office; thus, the duplication in names.

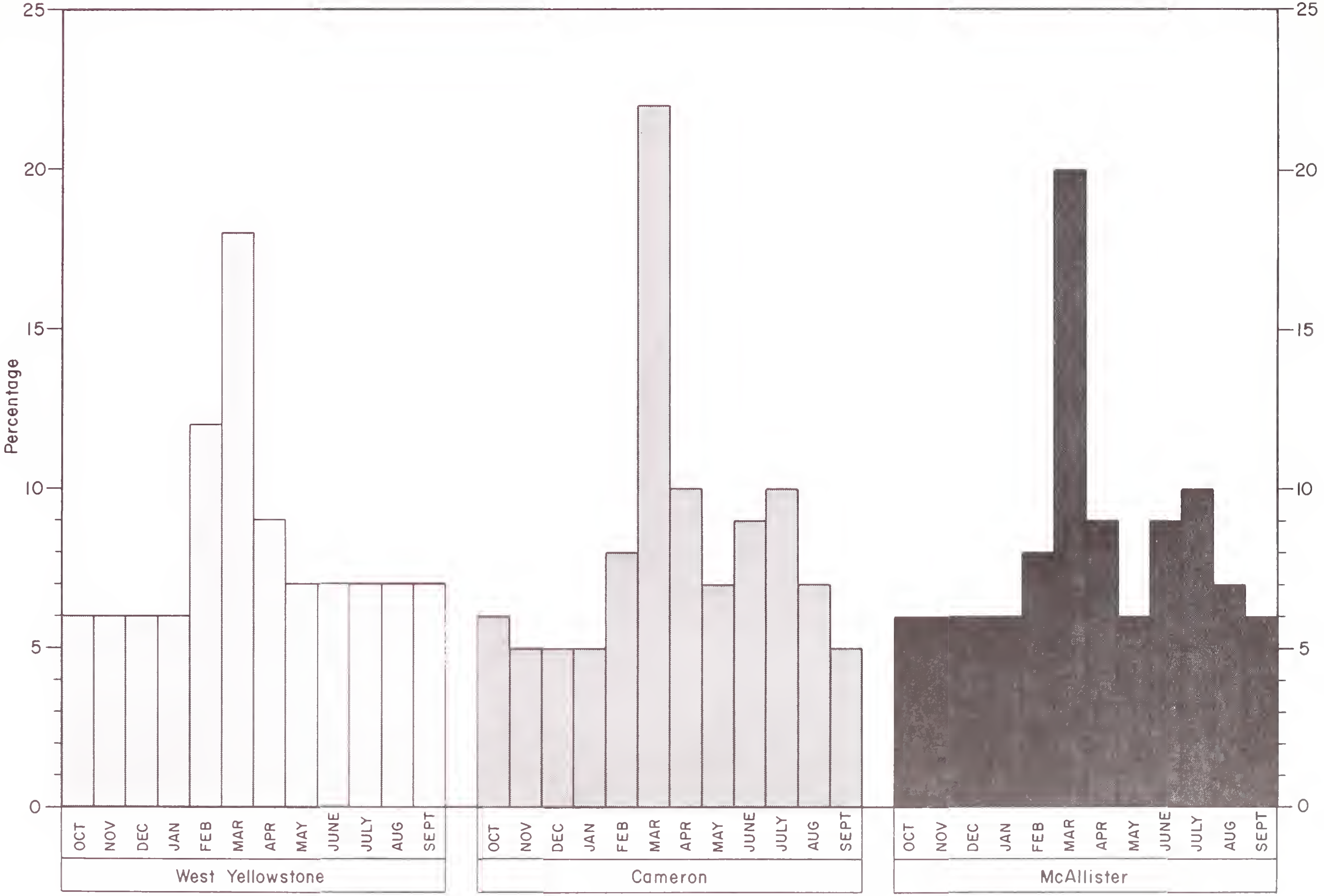
** cfs - cubic feet per second - equal to 448.8 gallons per minute.

*** A.F. - acre feet - equal to 325,900 gallons.

MADISON RIVER

PERCENT OF TOTAL FLOW
AT SELECTED GAGING STATIONS

WATER YEAR 1970



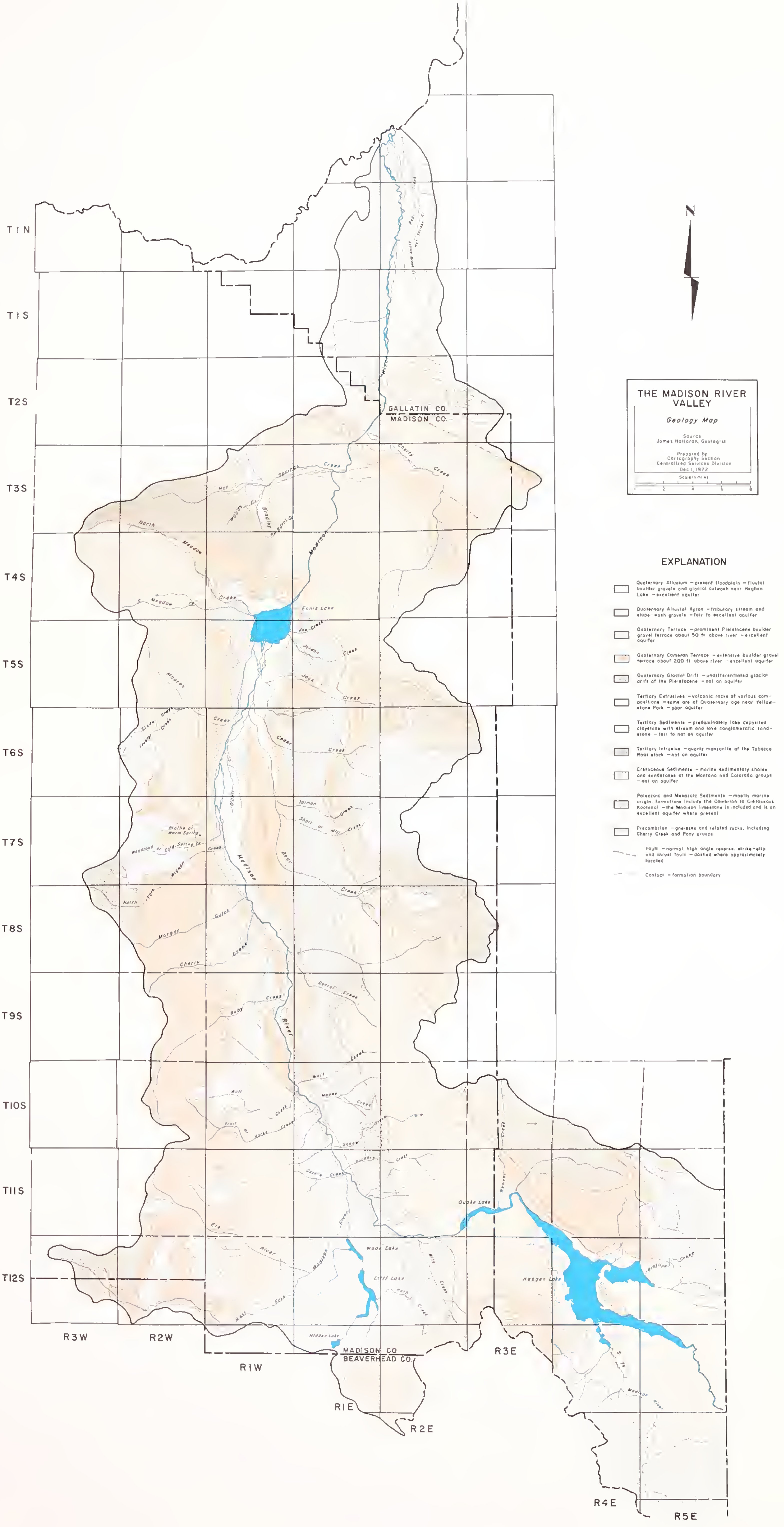
THE GROUND-WATER SITUATION IN THE MADISON RIVER VALLEY

A brief investigation of the ground-water resources was made early in October of 1972. The time has particular significance because the first of October is the beginning of the water year. At this time, too, stream flows are near their lowest levels, and irrigation has almost halted for the season. Before field work commenced, ground-water appropriations in the Madison Valley between the Norris Bridge and Earthquake Lake were inventoried. The field investigation consisted of measuring and estimating stream flows and studying the geology. Wells at numerous locations were examined in relation to the physiography. The stream flows were studied in order to determine the amount of water the Madison River and its tributaries lost to the underlying gravels.

Ground water constitutes a small part of the total water used in the Madison Valley, and practically all of it has been utilized for domestic and stock purposes. Underground water has been developed because it is readily available, relatively economical to develop, and less susceptible to contamination. As competition for surface water increases, there is often a corresponding increase in the use of ground water, especially if irrigation and industrial water supplies are involved. Such may be the case in the future of the Madison Valley. Our reconnaissance indicates that large quantities of ground water may be available.

The principal aquifers in the Madison Valley are the alluvium adjacent to the streams, the terrace deposits such as the Cameron Bench, and the alluvial fan deposits at the foot of the mountains. Other aquifers that may be of value are the Madison limestone formation and the deeper valley fill deposits beneath the aquifers mentioned.

The gravels along the Madison River beneath the active alluvium and the lower terrace (see geologic map) appear to have good permeability. Well completion tests suggest an average specific capacity of 5 gallons per minute (gpm) per foot of drawdown. (Specific capacity of a well is determined by dividing the amount of water discharged by the drawdown of the water level.) It should be noted that most of the wells have open ends rather than casing perforations. Wells with open ends do not penetrate the entire thickness of an aquifer and therefore have lower specific capacity values. Theoretical corrections for partial penetration show that the true specific capacity is closer to 100 gpm per foot of drawdown. The transmissivity (a measure of the permeability of an aquifer) of these gravel deposits would theoretically be 200,000 gallons per day per foot of drawdown. Thus, a properly constructed well should produce at least 1,000 gpm from the alluvium. Another indication of the permeability of these gravel deposits is the stream losses across them. The Madison River loses 75.8 cfs in the seven-mile reach between the town of Cliff Lake and the Kirby Ranch. (Table 2 shows the stream loss of the Madison River at various intervals.) This rate of infiltration through the stream bed indicates that



THE MADISON RIVER VALLEY

Geology Map

Source
James Holloran, Geologist

Prepared by
Cartography Section
Centralized Services Division
Dec 1, 1972

Scale in miles
0 2 4 6 8

EXPLANATION

☐ Quaternary Alluvium – present floodplain – fluvial boulder gravels and glacial outwash near Hegben Lake – excellent aquifer

☐ Quaternary Alluvial Apron – tributary stream and slope-wash gravels – fair to excellent aquifer

☐ Quaternary Terrace – prominent Pleistocene boulder gravel terrace about 50 ft above river – excellent aquifer

☐ Quaternary Cameron Terrace – extensive boulder gravel terrace about 200 ft above river – excellent aquifer

☐ Quaternary Glacial Drift – undifferentiated glacial drift of the Pleistocene – not an aquifer

☐ Tertiary Extrusives – volcanic rocks of various compositions – some are of Quaternary age near Yellowstone Park – poor aquifer

☐ Tertiary Sediments – predominately lake deposited claystone with stream and lake conglomeratic sandstone – fair to not an aquifer

☐ Tertiary Intrusive – quartz monzonite of the Tobacco Root stock – not an aquifer

☐ Cretaceous Sediments – marine sedimentary shales and sandstones of the Montana and Colorado groups – not an aquifer

☐ Paleozoic and Mesozoic Sediments – mostly marine origin, formations include the Cambrian to Cretaceous Kootenai – the Madison limestone is included and is an excellent aquifer where present

☐ Precambrian – gneisses and related rocks, including Cherry Creek and Pony groups

Fault – normal, high angle reverse, strike-slip and thrust fault – dashed where approximately located

Contact – formation boundary

the alluvium is hydraulically connected to the stream and that the alluvium is capable of transmitting relatively large quantities of water.

Terrace gravels beneath the Cameron Bench appear to be more permeable than the alluvium. The uncorrected average specific capacity of the wells on the Cameron Bench is 8 gpm per foot of drawdown. Here, too, most wells have no casing perforations and only partially penetrate the aquifer. Applying the same theoretical corrections, a specific capacity of 167 gpm per foot of drawdown can be calculated for wells on the Cameron Bench. An irrigation well located on the bench, which has 16 feet of perforated casing and a specific capacity of 120 gpm per foot, has been pumped at 900 gpm. Other properly constructed and located wells could yield similar amounts from the Cameron Bench gravel deposits.

The alluvial fan deposits appear to contain more clay and silt and are therefore less permeable than the alluvium. However, these more heterogeneous deposits do transmit water, as evidenced by stream losses. The losses along Indian, Bear, Cedar and Jack Creeks were estimated to total about 64 cfs in October 1972. The estimate was made from stream flow measurements and observations of flow or no flow in ditches. Although the estimated stream loss is relatively large, recharge to the fan deposits is probably even greater during the irrigation season. Data is not available to predict the yields of wells tapping the alluvial fan deposits, yet their water transmitting capability seems to indicate that large well yields are possible. The pumping lift in these deposits may be in excess of 200 feet.

Very little is known about the extent of the Madison formation, which crops out near the National Fish Hatchery and may be the source of its water. It could underlie the valley, but the geology under the valley is poorly understood. The Madison formation yields 34 cfs at Blaine Springs and 13.6 cfs into Wigwam Creek. This ground-water discharge indicates that the Madison formation contains permeable zones and is full of water.

Deeper valley fill deposits appear to have fair to poor permeability. However, the fill is hundreds of feet thick and could yield 500-1,000 gpm to a properly constructed well.

Surface and ground water are obviously interrelated in the Madison Valley. Tributaries flowing into the valley lose much of their flow into the alluvial fan and terrace deposits. Water in these deposits moves slowly toward the Madison River and is eventually discharged into the river or lost by evapotranspiration. Ground-water discharge to the Madison River from the area drained by O'Dell Creek and the lower part of Bear and Cedar Creeks was 173 cfs. Water from this discharge area was recharged on the Cameron Bench between Cameron and Ennis and on the Bear, Mill and Cedar Creeks' alluvial fans. If the measured ground-water discharge on October 3-4, 1972, is taken to be indicative of the average annual ground-water discharge, the annual discharge of ground water is nearly 130,000 acre feet from that part of the valley.

This reconnaissance investigation indicates that large supplies of ground water may be available in the Madison Valley and that the ground-water supply is closely related to the surface water supply. Although conclusive evidence has not yet been collected, the geologic and hydrologic situation appears favorable for developing a highly integrated water supply system in the valley. Should these indications be proven, water development could be increased in the valley by conjunctive use of surface and ground water. Pumpage from wells tapping the alluvium or terrace deposits could provide supplemental irrigation water during the summer and create underground storage space that would be refilled during the spring. A second possibility for conjunctive use would be to utilize ground water for the total irrigation supply in some areas, thus leaving more surface water in other areas where large supplies of ground water are not available. Should additional surface water be supplied to the Cameron Bench, conjunctive use would become more attractive and would probably take place even if unplanned. Increased recharge from new diversions onto the bench would raise ground-water levels, thus decreasing the pumping lift and increasing the yield of wells, making their use more economical.

Table 2 is intended to show the stream loss to the underlying gravel deposits. These stream flow measurements were taken October 3 and 4, 1972, at various points along the Madison River and its tributaries. The tributaries were often checked at several points; that is, where they flow from the mountains, above the diversions and at the confluences with the Madison.

Interpretations can be made on these data that show stream gain or loss through a certain interval. Examples of these interpretations are listed below.

1. The Madison River at McAtee Bridge flowed 2,155 cfs, but at Varney Bridge it has only 2,069 cfs, in spite of the 47.6 cfs that joined the Madison through the interval.

2. Jack Creek above the diversions had 24.6 cfs, while near the mouth it had only 2 cfs.

The opposite is true, too. The streams gain due to ground-water seepage into the channel.

1. The Madison River gained 334 cfs from groundwater and 217 cfs from stream contribution between Varney Bridge and Norris.

2. Bear Creek flowed from the canyon mouth at a volume of only 15.7 cfs, but where it joined the Madison it had gained 10.2 cfs.

TABLE 2 STREAM FLOW DEPELTION AND ACCRETION

Stream	Discharge (cfs)
Madison River at Cliff Lake	2,015
Spring at Cliff Lake	4.8
Curlew Creek near mouth	1.7
Butte Creek at mouth	2.1
West Fork Madison River	73.8
Papoose Creek near mouth	6.4
Total Tributary Inflow	88.8
Theoretical Combined Flow	2,103.8
Actual Flow After This Interval	2,028.0
Difference (loss to (-), or gain from (+) ground water)	-75.8
Madison River below Kirby Ranch	2,028
Squaw Creek near mouth	17.2
Moose Creek near canyon mouth	.8
Moose Creek near mouth	8.5
Wolf Creek near mouth	16.1
Nickerson Creek	.6
Hyde Creek	1.6
Ruby Creek near mouth	11.0
Indian Creek above diversions	53.8
Diversion from Indian Creek	8.0
Indian Creek near mouth	.0
Total Tributary Inflow	45.0
Theoretical Combined Flow	2,073.0
Actual Flow After This Interval	2,155.0
Difference (loss to (-), or gain from (+) ground water)	+82.0
Madison River at McAtee Bridge	2,155
Blaine Spring	34.0
Wigwam Creek near mouth	13.6
Total Tributary Inflow	47.6
Theoretical Combined Flow	2,116.6
Actual Flow After This Interval	2,028.0
Difference (loss to (-), or gain from (+) ground water)	-88.6
Madison River at Varney Bridge	2,069
O'Dell Creek near mouth	143
Bear Creek above diversions	10.6
Bear Creek below canyon mouth	15.7

Table 2 Cont.

Stream	Discharge (cfs)
Bear Creek	.7
Bear Creek at mouth	25.9
Boulder Creek near mouth	4.2
Cedar Creek above diversions	8.8
Diversions from Cedar Creek	4.4
Cedar Creek near mouth	.0
Jack Creek above diversions	24.6
Jack Creek near mouth	2
North Meadow Creek	19.9
North Meadow Creek near mouth	35.8
South Meadow Creek	9.3
South Meadow Creek near mouth	6.1
Madison River near Norris	2,620
Total Tributary Inflow	217.0
Theoretical Combined Flow	2,286.0
Actual Flow After This Interval	2,620.0
Difference (loss to (-), or gain from (+) ground water)	+334.0

MADISON BASIN POPULATION AND ECONOMY

A general understanding of the economy of a study area can provide much insight regarding problems and possible alternatives. In recent years there have been several studies, which have focused all or in part on the economy of the Madison area.

The involvement of the public in the planning process can serve as a needed check on non-resident planners through review of their analysis and conclusions utilizing a high degree of personal familiarity. A matter which was brought out at the public meeting in Ennis was that Madison County and the Madison Basin are two separate and, in many ways, quite different areas. Roughly 40% of Madison County lies within the Madison Basin, and 74% of the Basin lies within the county. Because of a shortage of easily accessible data, some of this section has been based on county figures. For this type of review, however, such an analysis can often give a reasonable approximation of conditions in the Basin.

Population

As Table 3 and Figure C show, the population in Madison County has been declining since 1940. The Comprehensive Plan for the Ennis City-County planning area (which is a circle twelve miles in radius around Ennis) estimates that the Ennis population decreased at a greater rate than that of the county from 1960 to 1970, but that during the same period the planning area showed a net increase of over 9%. Since the planning area is probably most representative of the Basin, the Basin seems to be changing somewhat differently than the county.

Figure B, a "demographic tree," illustrates population distribution by age and sex in Madison County in 1930, 1950, and 1970. The demographic tree graphically shows that the county population is becoming proportionately older with the passage of time. Generally this is an indication of a lack of opportunities in a regional economy, resulting in an exodus of people in their earlier years of adult employment. In the long run this is not a healthy economic sign. Although some of the maldistribution may be attributed to the emergence of Madison County as a retirement area, this probably accounts for very little of the change. In most cases population is closely related to the job base in an area. A review of the 1970 age distribution for the planning area, as reported in the Comprehensive Plan, indicates that its demographic tree was balanced more like Madison County's in 1950, rather than "top heavy," as the county was in 1970.

Employment

As can be seen in Table 3 and Figure C, total county employment has declined since 1930. The only sectors showing substantial increases in that period were services (which includes retail sales establishments, government, and teachers) and construction. As a percent of total employment, service has steadily increased from 24% in 1930 to nearly 45% in 1970. Construction, providing a much smaller share of jobs, has been erratic. Table 4 summarizes employment in the Ennis planning area in 1970. The Comprehensive Plan does not include similar estimates for any year prior to 1970.

Because recreation and tourism are obviously having an effect on the Basin's economy, they should be mentioned. There is no statistical data series which differentiates recreation from other sectors of the economy. The increasing importance of services employment is probably an index of recreation's growing significance.

A more detailed and current picture of the local labor market can be found in the "Area Manpower Review" (A.M.R.) prepared by the Montana Division of Employment Securities, May 25, 1972. The A.M.R. is a federal requirement to qualify an area for Economic Development Administration (E.D.A.) assistance. In 1971 the average unemployment rate in Madison County was 8.0%, compared with 7.0% for Montana and 5.9% for the nation. The A.M.R. reports that a surplus of labor for all activities is common to Madison County, and migration of workers from larger outside communities occurs on a very small scale.

TABLE 3 MADISON COUNTY POPULATION AND EMPLOYMENT HISTORICAL AND PROJECTED 1930 - 1985 *

	1930	1940	1950	1960	1970	1980	1985
Population	6,323	7,294	5,998	5,211	5,014	4,424	4,178
Employment Total	2,703	2,622	2,381	2,072	1,945	1,697	1,588
Agriculture	1,624	1,252	1,264	973	810		
Forestry & Fisheries	16	19	13	29	23		
Mining	210	532	134	84	67		
Construction	93	88	143	75	142		
Manufacturing	105	21	63	15	33		
Services and Other	655	710	764	896	870		
Total Emp/Population	.427	.359	.397	.398	.388	.384	.380
Services Emp/Total Emp	.242	.271	.321	.432	.447		

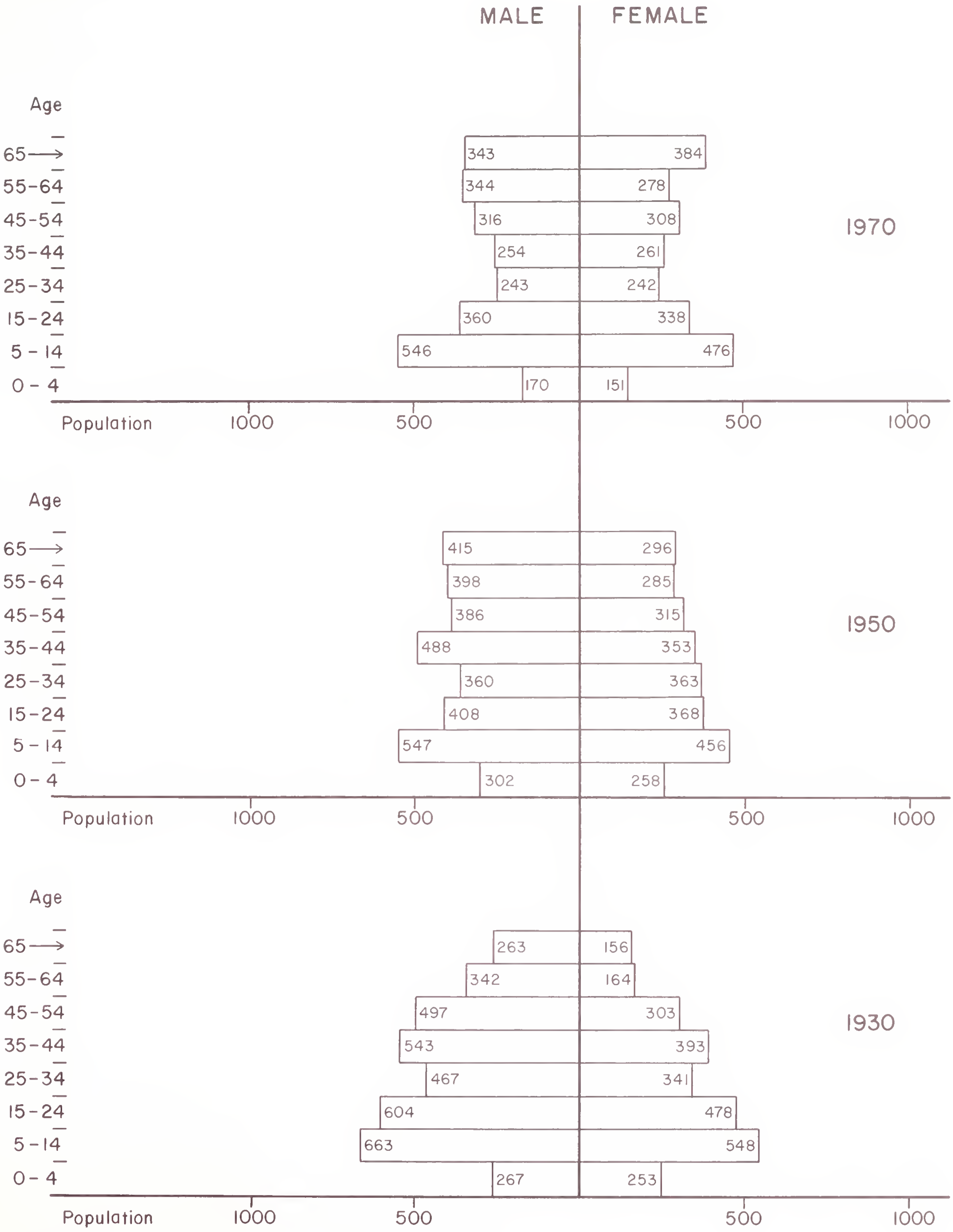
* Historical data from U.S. Census of Population, 1970; Projections by Montana Department of Natural Resources and Conservation.

TABLE 4 EMPLOYMENT BY INDUSTRY, ENNIS CITY-COUNTY PLANNING AREA, 1970 *

Total Employment	517
Agriculture, Forestry, and Fisheries	209
Mining	2
Construction	15
Manufacturing	0
Transportation & Public Utilities	21
Wholesale and Retail Trade	111
Services & Finance	96
Government	60
Other	3

* From Ennis Comprehensive City-County Plan.

Population by Age and Sex, Madison County*



* Source: U.S. Dept. of Commerce, Census, 1930, 1950, 1970.

Figure C

HISTORICAL & PROJECTED POPULATION & EMPLOYMENT

1930 - 1985

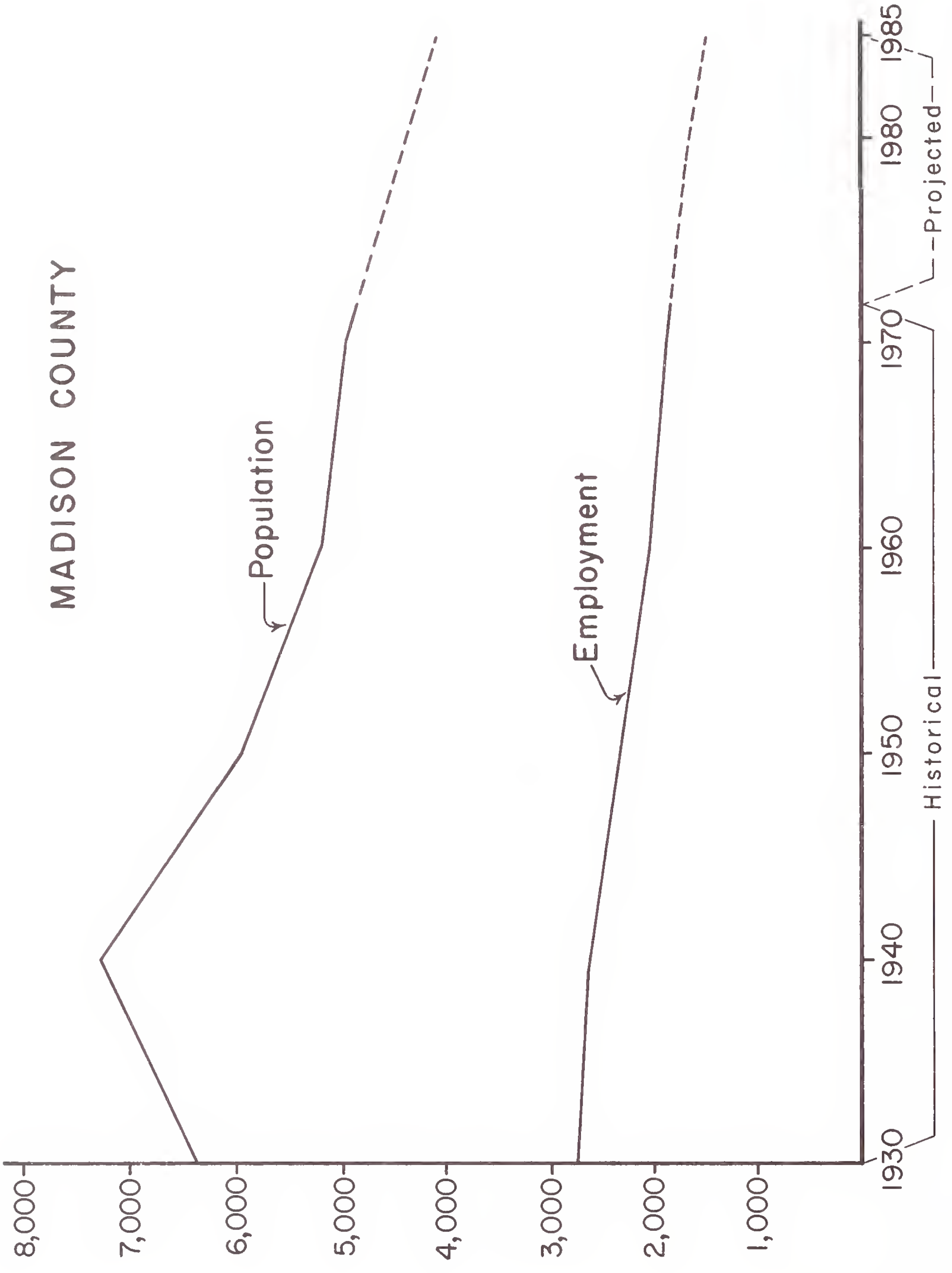


Table 5, taken from the Madison County A.M.R., shows the labor market situation by month for Madison County in 1971.

TABLE 5

MONTHLY CIVILIAN LABOR FORCE, MADISON COUNTY, 1971

	Civilian Labor Force	Total Employment	Nonagri. Employment	Agri. Employment	Total Unemployment	Unemployed as Percent of Labor Force
	Number of Persons					Percent
January	1,980	1,710	1,000	710	270	13.5
February	2,030	1,730	1,000	730	300	14.9
March	2,080	1,820	1,030	790	260	12.6
April	2,170	1,970	1,060	910	200	9.2
May	2,090	1,910	1,110	800	180	8.4
June	2,240	2,090	1,280	810	150	6.7
July	2,240	2,140	1,330	810	100	4.3
August	2,260	2,180	1,350	830	80	3.7
September	1,890	1,820	1,250	570	70	3.7
October	1,890	1,820	1,150	670	70	3.6
November	2,070	1,940	1,130	810	130	6.4
December	2,170	1,960	1,100	860	210	9.6

Projected Population and Employment

In order to give planners a future reference point, in Table 3 and Figure C we have projected county population and total employment to 1980 and 1985. This should be interpreted as being what is likely to occur if the trends from 1950 to 1970, as recorded in the census, are to continue. Obviously, if there is an unexpected economic stimulus or disaster, the projections will not be realized. As can be seen, we project a decline in both population and employment.

Income and Social Welfare

In 1970 Madison County was in the lower half of all Montana Counties in per capita personal income, which was $3,316 per person.[1] The following table shows an income comparison with the state.

---

[1] From "Montana Personal Income," Bureau of Economic Analysis, Dept. of Commerce, available from Montana Division of Planning and Economic Development, 1972.

TABLE 6

FAMILY AND UNRELATED INDIVIDUAL INCOME
MADISON COUNTY AND MONTANA. 1969 *

	Montana	Madison County
Number of Families and Unrelated Individuals	239,648	1,786
Median Income	$6,766.00	$5,557.00
Mean Income	$7,846.00	$8,624.00

* From 1970 Census, U.S. Department of Commerce

The median income is over $1,200.00 less than that of the state, and the mean (or average) is nearly $800.00 more. In Montana the difference between mean and median is $1,080.00, while in Madison County the spread is $3,067.00. This and Figure C, which follows, show that in Madison County there are proportionally more families in the lowest and highest income groups than in the state, and statewide there are more in the middle and higher middle groups.

An analysis of public welfare assistance also tells an interesting story. Using 1970 census population figures and 1968 and 1969 welfare expenditures for the state and Madison County, the per capita expenditures in Madison County were approximately 145% of those for Montana.

TABLE 7

ESTIMATED PER CAPITA WELFARE EXPENDITURES
MONTANA AND MADISON COUNTY, 1968 and 1969 *

	1968	1969
Montana	$29.56	$33.27
Madison County	$42.42	$48.52

* State and county totals from Montana Data Book; Population from 1970 Census of Population.

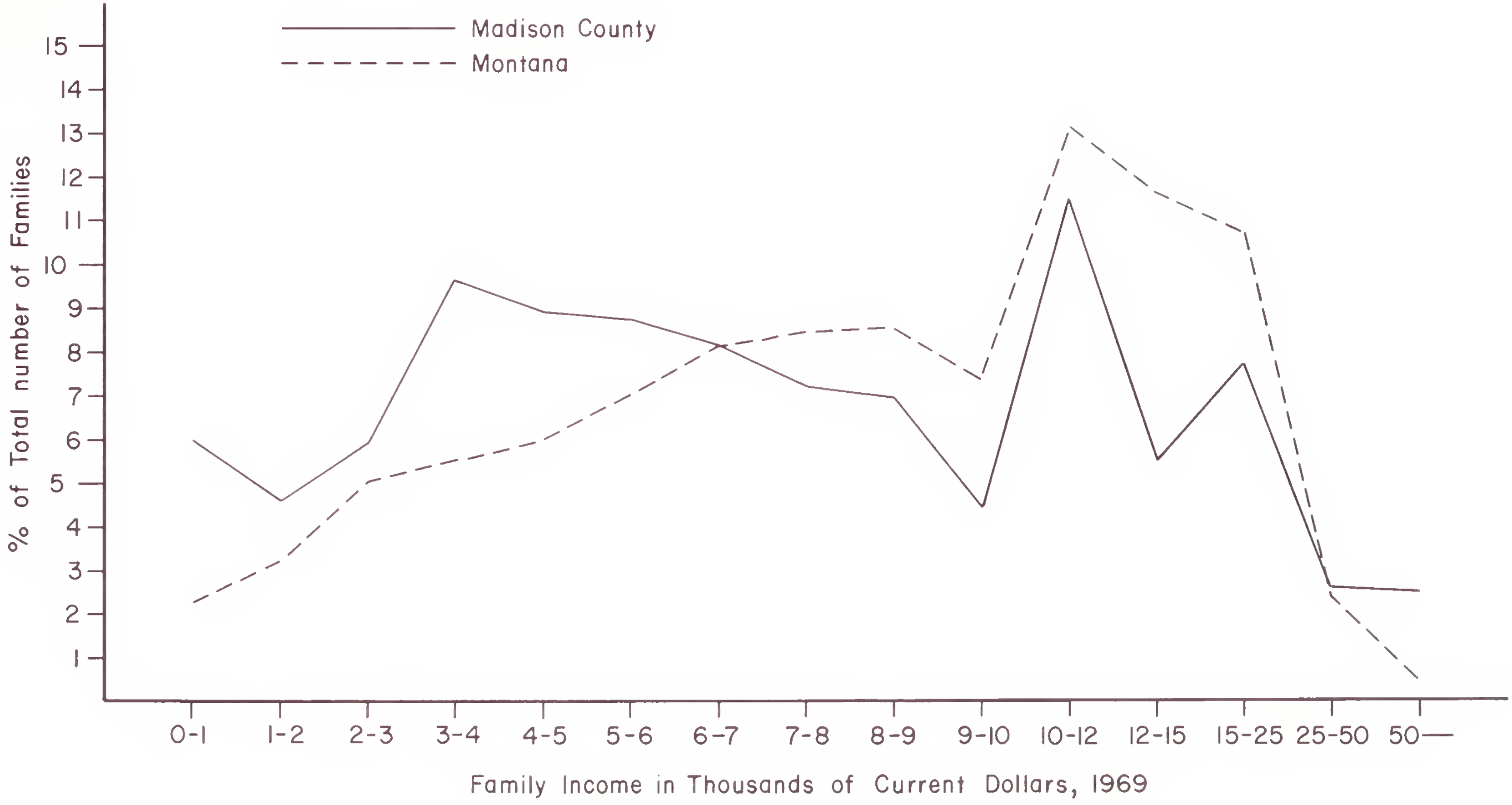
In 1969, 15.6% of Madison County's families had an income below the poverty level.[1] Only ten counties had a higher percentage.

---

[1] From U.S. Department of Commerce, 1970 Census. The poverty level income used in the census varies depending on several factors. C.F. U.S. Department of Commerce, 1970 Census of Population.

Figure D

Distribution of Family Income - Madison County and Montana, 1969*



* Source: U.S. Dept. of Commerce, 1970 Census of Population

The general condition described above has resulted in Madison County's being designated an area eligible for E.D.A. assistance. Madison County is the eastern-most member of the southwestern Montana E.D.A. district.

Services Available and Local Trading Patterns

Although many necessary services are available in the county, some are not. The Ennis Comprehensive Plan has shown that convenience goods, such as food, drugs, hardware and gasoline, and consumers' goods, such as those purchased from eating and drinking establishments, are provided locally. Shoppers' goods, such as automobiles, furniture and appliances, are purchased outside the county. Wholesale trade in the county has declined in the past fifteen years and is not considered to be of great importance.

Agriculture

Because of the importance of agriculture to the local economy and to possible water development alternatives, Tables 8, 9, and 10 are included.

TABLE 8

CROP SUMMARY, MADISON COUNTY, 1969 *

Crop	Acres Planted	Acres Harvested	Yield	Value ($)
All Irrigated	---	88,100	---	4,421,300
All Not Irrigated	---	16,700	---	558,400
Winter Wheat	7,100	7,000	31.8bu/A	267,900
Spring Wheat	1,600	1,500	42.9bu/A	82,300
Oats	5,000	2,500	50.8bu/A	76,800
Barley	7,200	6,600	47.1bu/A	249,800
Potatoes	600	550	169Cwt/A	373,200
All Hay	---	86,600	2.03Tn/A	3,929,700
Alfalfa Hay	---	44,000	2.49Tn/A	---
Wild Hay	---	10,500	1.38Tn/A	---

TABLE 9

LIVESTOCK ON FARMS, MADISON COUNTY, 1968, 1969, 1970 *

Type of Livestock	Number Jan. 1, 1968	Jan. 1, 1969	Jan. 1, 1970
Cattle and Calves	99,000	108,000	104,000
Sheep and Lambs	38,000	37,000	39,000
Hogs and Pigs	2,600	3,000	2,200
Chickens	8,900	8,000	7,300

---

* From Montana Agricultural Statistics, Vol. XIII, Dec. 1970.

TABLE 10 CATTLE MOVEMENTS, MADISON COUNTY, 1969 *

	Number	Ranking Among Mont. Counties
Moved out of County	60,504	12
Moved into County	18,638	19
Net Movement out of County	41,866	7

* From Montana Agricultural Statistics, Vol. XIII, Dec. 1970.

Outlook for the Future

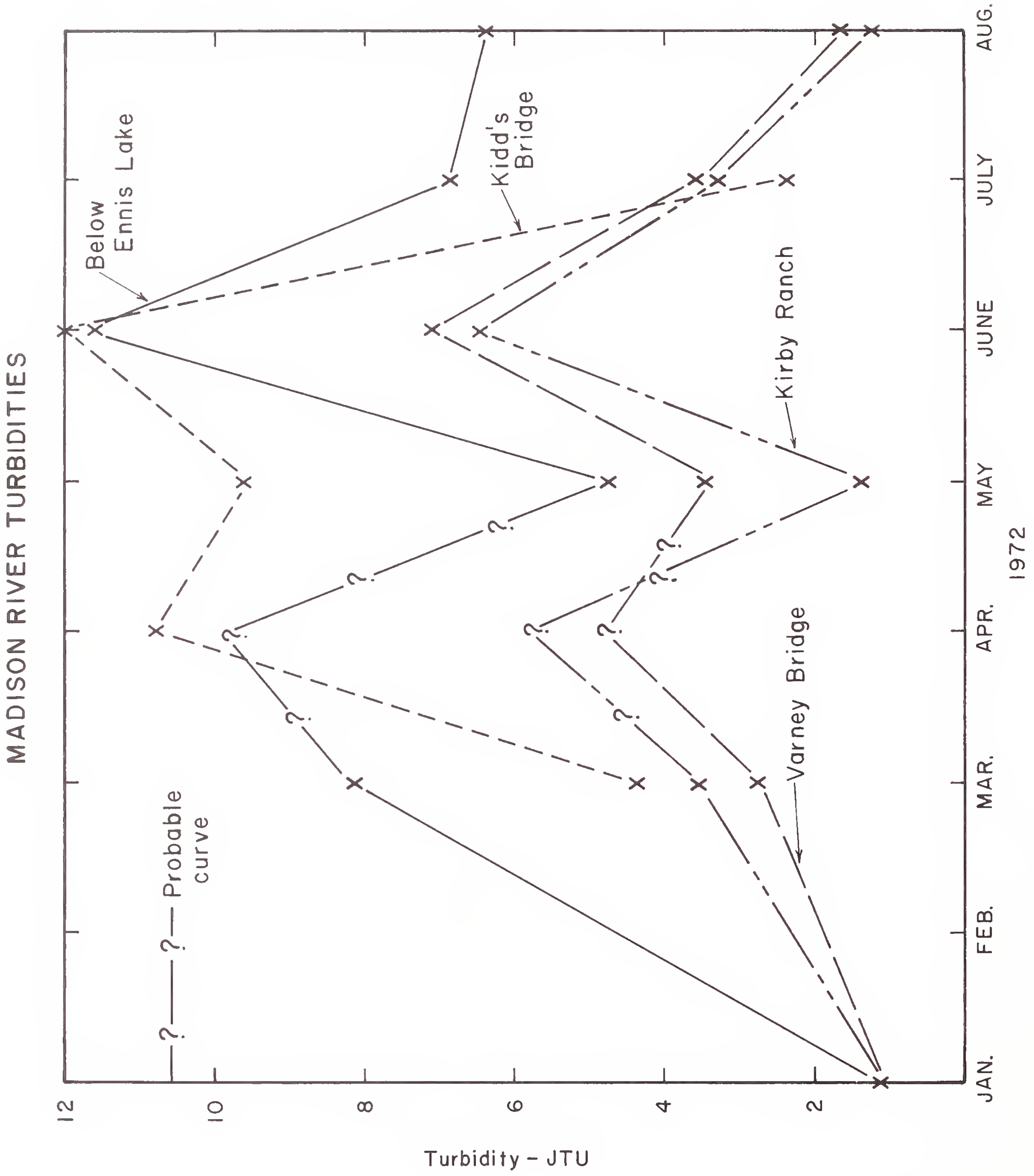
Based on the preceding analysis, some general observations on the economic future of Madison County can be made. The current economic base consists primarily of agriculture, government and recreation. Looking into the future, agriculture will likely be stable but gradually decreasing in importance. State and federal government employment is expected to be stable and slowly increasing. The biggest unknown is the role recreation will play. Based more upon intuition and communication with residents of the Basin than upon any analysis, it seems quite likely that recreational activities in the Basin will continue to show a strong increase. Another unknown surrounds the possible development of the extensive mineral resources in the Basin. As these basic activities grow or shrink, the remaining "service" activities can be expected to do the same.

MADISON RIVER WATER QUALITY

High quality water directly influenced the expending of 125,000 fisherman-days in the Madison River drainage in 1970, and this use is increasing. Agriculture, municipal water supply, and other forms of recreation are also directly or indirectly related to water quality (Madison River Test Case, Bureau of Reclamation, November, 1971). The current land boom near Ennis is due in part to the desirability of living near a stream with nationwide prominence for trout fishing. Protection of water quality in the Madison Basin, therefore, is not only desirable, but an essential economic element in the Basin. The Water Quality Bureau of the State Department of Health and Environmental Sciences, charged with the responsibility of protecting water quality in Montana, presently is investigating the quality of water of the Madison River drainage.

Water quality is dynamic and variable, and, consequently, it is influenced by natural factors within the watershed and by man. The relatively undisturbed watershed of the Madison River yields high quality water. Maintenance of water quality, therefore, is dependent upon man's ability to control his impact, and to control the impact it is necessary to measure it. Therefore, the Water

Figure G


MADISON RIVER TURBIDITIES
Turbidity - JTU
12
10
8
6
4
2
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
1972
?——?— Probable curve
Below Ennis Lake
Kidd's Bridge
Kirby Ranch
Varney Bridge

Quality Bureau established four monthly sampling stations on the main stem of the Madison River and one at the Ennis sewage treatment lagoon discharge in January 1972. Samples collected at stream locations are analyzed for parameters listed in Table 11. Flow, total coliforms and biochemical oxygen demand are determined for the Ennis lagoon discharge. From this study, baseline information on existing water quality was obtained, zones of initial influence were delineated, and areas needing additional study were established.

Water quality information, other than sediment studies, from other agencies and private organizations is scarce. Records (1972) of the U.S. Geological Survey indicate only one water quality monitoring station in the Madison Basin. This was established in July 1972 at the powerplant below Ennis and replaces the Water Quality Bureau station at this location. August 1972 data are included in the mean figures of Table 11. Data have been collected over several years by the Anaconda Company, but to date these data have not been released to the state. It is expected that this information will be made public in the near future, as it would benefit all Montanans by showing the quality standards that are necessary to maintain a river of the Madison's status. The Montana Fish and Game Department sponsored temperature studies in the Madison drainage from May 1960 to July 1962. Three locations on the Madison River and twelve points on tributary streams (all stations within Yellowstone Park) were sampled during May and August, 1970, as part of the Yellowstone National Park Baseline Water Quality Survey Report (EPA, 1972).

Madison River water is a calcium bicarbonate, low hardness water of excellent quality (Table 11). Gradual increases in dissolved mineral concentrations (Table 11) and turbidity occurred between Kirby Ranch and Kidd's Bridge stations. However, changes were small, and the overall water quality was not impaired. The Madison River would be a good source for public supply, but treatment of the water would be necessary to control turbidity, arsenic and fluoride. Turbidity is high during spring runoff, and arsenic and fluoride generally exceed 0.05 mg/l* and 1.7 mg/l respectively (U.S. Public Health Service maximum limits). These factors, and the availability of good ground water, have precluded using river water for municipal use, and Ennis and Jeffers have the only public water supply systems in the Madison Basin.

A valid permit from the Department of Health and Environmental Sciences is required before waste (industrial or treated domestic sewage) is discharged to Montana streams. The only Madison Basin permit at present is for discharge from the Ennis sewage treatment lagoon. There are no apparent adverse effects on the Madison River from this discharge due to the low biochemical oxygen demand of the waste. Private sewage disposal is by cesspools or septic tanks with seepage pits or drainfields; however, direct discharges to streams have been found. Corrective actions have been initiated on all known direct discharges.

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* mg/l - milligram per liter = parts per million.

TABLE 11 WATER QUALITY AT SELECTED MADISON RIVER LOCATIONS

Station	Kirby Ranch (1), (4)	Varney Bridge (1)	Ennis Lake (1), (2)	Madison River Average (3)
Physical Parameters				
Flow (cfs)	-	2700	1945	-
Temp. (^oC)	7.8	5.4	10.5	9.2
pH	7.8	7.8	7.8	7.8
Color (CU)	12	10	22	14
Turbidity (JTU)	2.8	1.9	6.3	4.7
Suspended & Dissolved Solids (mg/l)	150	167	156	163
Chemical Parameters				
Conductivity micromhos 25^{o}C	250	280	305	280
Cations				
Calcium (mg/l)	14.2	16.6	19.6	17.8
Magnesium (mg/l)	3.5	4.1	5.3	5.2
Total Hardness (mg/l as $CaCo_3$)	50	63.5	71.0	66.0
Sodium (mg/l)	18.9	26.5	19.1	23.4
Lead (mg/l)	0.006	0.004	0.006	0.007
Arsenic (mg/l)	0.054	0.045	0.034	0.045
Iron (mg/l)	0.115	0.164	0.300	0.238
Zinc (mg/l)	0.077	0.034	0.027	0.044
Copper (mg/l)	0.021	0.016	0.013	0.018
Anions				
Bicarbonate	82.4	101.3	115.4	121
Sulfate	9.1	14.9	10.6	12.5
Chloride	16.0	18.8	12.8	15.3
Nitrate as Nitrogen (mg/l)	0.04	0.03	0.05	0.04
Total Phosphate	0.03	0.03	0.02	0.02
Fluoride (mg/l)	2.01	1.93	2.12	2.01

Table 11 Cont.

Station	Kirby Ranch (1), (4)	Varney Bridge (1)	Ennis Lake (1), (2)	Madison River Average (3)
		Biological		
Biochemical Oxygen Demand - mg/l	0.46	0.56	1.21	0.95
Total Coliforms/100 ml	930	4600	1300	2000
Dissolved Oxygen - mg/l	9.2	10.0	10.5	9.7

(1) arithmetic mean for January, 1972 through August, 1972

(2) heavy metal concentrations not run by USGS in August

(3) arithmetic mean for Kirby Ranch, Varney Bridge, Ennis Lake and Kidd's Bridge - water quality sampling stations (January, 1972 through August, 1972)

(4) inactive USGS gaging station (no recent flow data available)

NOTE: 1 milligram per liter (1 mg/l) = 1 part per million (1ppm)

Metals were determined from an unfiltered sample to which 5 ml of concentrated HNO_3 were added.

Data accumulated to date are incomplete and inconclusive. Much additional work needs to be done before the Madison River and its tributaries are understood well enough for the formulation of a plan to protect water quality. Items needing further study are:

1. What is causing the Madison's West Fork to carry such a heavy sediment load? Steps to correct the problem can be taken only after this question is answered.

2. What effect has Ennis Lake on the downstream temperatures? Fish and Game Department (1962) officials feel anything that would further increase water temperatures in the Madison River would be very detrimental to the downstream fisheries.

3. What is the significance of an increased coliform bacteria population between the West Fork and Varney Bridge stations? Does the increase occur every year? Are the coliforms of fecal origin, and, if so, is their origin animal or human?

4. What quality changes occur in small tributary streams such as Bear, Indian and Jack Creeks, due to their use for irrigation?

5. What will be the effect of significantly increased recreational use of the Madison River? The impact of this use must be considered in developing a water quality management plan for the Basin.

6. What are the effects of Hebgen and Quake Lakes on Madison River quality? Water samples should be collected above these impoundments.

While the Department of Health has not gathered enough data at the present time to present conclusive evidence, its contention is that water quality in the Madison River has been adversely affected by the changing land use pattern in its Basin, and the most significant problems appear to be:

1. Ennis Lake is shallow and causes a warming of the river downstream during the summer months. This has adversely influenced the fishery and could be disastrous to aquatic organisms. A temperature differential of 9 to 12° F was recorded by the Water Quality Bureau between Varney Bridge and the powerplant during the period from May through July, 1972. Significant warming due to Ennis Lake also was observed in Fish and Game temperature studies from 1960 through 1962.

2. Heavy spring sediment loads carried by the Madison's West Fork change an otherwise clear main stream to a muddy stream. Records of the U.S. Forest Service (1972) for the past six years indicate that over 10,000 tons of sediment annually enter the Madison River

from its West Fork. Natural geologic erosion is thought to be the major cause. The Bureau of Reclamation (1971) notes Madison Basin soils are unstable and easily eroded.

3. Total (fecal and non-fecal) coliform counts for July and August, 1972, were approximately three times higher at Varney Bridge than at the other three stations. A maximum of 8,000 organisms/100 ml (milliliters) was recorded at Varney Bridge and 2,500/100 ml at Kirby Ranch. A mean of 1,000 fecal coliforms per 100 ml is the recommended limit for water with recreational use other than primary contact (Federal Water Pollution Control Administration, 1968).

4. Resuspension of sediment by wave action in Ennis Lake, a high algae population in the lake, or a combination of both are probable explanations for the higher turbidity below Ennis Lake.

Summary

Complacency and the accumulation of subtle and seemingly unimportant degradations have ruined the water quality of several streams in Montana, including Muddy Creek in Teton and Cascade Counties, Silver Bow Creek and Deer Lodge Creek. As previously mentioned, the water quality of the Madison River is high, and, although the Department of Health has only one year of measurements, there are some water quality problem areas in the Basin. Unless studies are continued, development of an effective water quality management plan for protecting existing waters is impossible. It is interesting to note that three of the four problem areas are man caused, with the sediment problem being the exception. If the expected development pattern, that of increasing use of the lands adjacent to the river, takes place, and assuming that the residents of the area want the present quality of the river to be retained or improved, a high priority must be assigned to adopting a policy that would control and eliminate future degradation of water quality by man.

HYDRO-POWER

The Madison River is regulated for power purposes by Hebgen and Madison Dams. Hebgen Dam, in the upper stretch of the river eighteen miles northwest of West Yellowstone, has been for many years the storage backbone of the Montana Power Company's Missouri main stem power generating system.

Beginning with the breakup of ice on Hebgen reservoir and the spring runoff in April and May, no "normal" releases (800-1,000 cfs) are allowed until 170,000 acre feet storage has been obtained (or the reservoir is full). Releases of 500-600 cfs are normal for late winter and early spring (March

15-July 1) and are generally guaranteed for fish propagation purposes, which is in keeping with a standing request by the Montana Department of Fish and Game. A flow of 50 cfs is an absolute minimum in extremely dry years.

From July 1 to September 15, the reservoir is lowered 4½ feet (50,000 acre feet) at a flow of 1,000-1,100 cfs to maintain the level of the lake for recreational water use.

During the prime recreational season (June 1 to October 1), the project license issued by the Federal Power Commission states that the pool elevation shall be held at 6,530.26. The U.S. Forest Service requested and received from the F.P.C. an exception for a three year period to allow a greater margin for the protection of the Quake Lake Channel. Rather than June 1, the target date to reach elevation 6,530.26 is June 20 for the years 1971, 1972, and 1973.

Beginning somewhere between September 1 and September 15 the power company begins what it terms "recreational flows release." This constitutes a flow of 1,400 cfs, spilling 70,000 acre feet of water, with the object of releasing up to 120,000 acre feet of storage before December 1 when ice formation begins.

From December 1 to March 15, or until the ice goes out on Hebgen Reservoir, essentially no storage is allowed. Natural flow conditions are maintained, and no flood flow manipulations are utilized. The power company feels that less legal action will result from maintaining normal stream flows during ice formation and breakup periods and therefore exerts no control over flows until after ice breakup occurs.

A reserve storage of 40,000-50,000 acre feet is maintained to assure filling the reservoir in the spring. If, following spring ice breakup, it appears that sufficient runoff will be available to fill the reservoir, then additional early season releases are made. This might be called flood flow regulation of the reservoir, but it is strictly an incidental benefit and is not guaranteed by the power company.

Downstream on the Madison, Ennis Lake supplies regulation of flows for the Madison Power Plant. The power company operates the plant for power production only and follows the same general guidelines as for Hebgen Dam.

Full capacity for power production utilizes 1,600 cfs of water, which is generally supplied by releases from Hebgen and accretion of tributary flows above Ennis Lake. Only during the fall flow release season does the power plant operate at full capacity while spilling an additional 300 cfs of water. This is due to increased flows at Hebgen and decreased de-watering of the Madison River for agricultural use.

Again, nearly all the water released for power generation at the Madison Power Plant is available downstream. A management understanding has been reached between the power company and the Bureau of Reclamation with regard to Canyon Ferry Dam near Helena to provide each with the requirements necessary for power generation and minimum reservoir and stream level information at each site.

MUNICIPAL, INDUSTRIAL, AND RURAL-DOMESTIC WATER USE

The use of Madison River water for municipal, industrial, rural, and domestic consumption is by far the least important of all uses from the standpoint of water consumption. There are no major industrial water users in the Madison River Valley, and any potential for industrial water use will be discussed in later chapters. The water used by the community of Ennis, as well as most rural farm and domestic water, is obtained from ground-water sources which, while related to surface water supply, pose no problem concerning excess utilization or streamflow depletion.

Ennis has a population of 500 people (206 families) who utilize 40,000 gallons of ground water per day, or forty-five acre feet of water per year, from a well maintained by the city. According to the Comprehensive Plan for the Ennis area, the community of Jeffers has a community water system serving forty-five persons with 9,000 gallons per day, or ten acre feet per year.

The use of on-farm rural-domestic water through 235 private systems does not, in all probability, exceed 250 acre feet per year, and livestock water use approaches 700 acre feet per year. When compared to agricultural water consumption, which could range from 80,000 to 110,000 acre feet per year, the total water consumed by municipal, rural-domestic, and livestock water use is about 1% of the total water used in the Madison River Valley.

PRESENT AND FUTURE AGRICULTURAL SITUATION

Introduction

The major features that determine the desirability of an area for irrigation development are the type of soil, topography, availability and quality of irrigation water, climate and markets. Soils and topography, together with frost free season and mean temperature, largely determine the ability of an area to produce, assuming that a dependable water supply is available. Finally, a market is necessary to obtain a profit from crops that are produced. This section is based on a reconnaissance land classification and resource study which disregards the present available water supply for irrigation and market factors of crops produced.

Land classification is the process by which soils, relief and climate are systematically appraised and lands are placed in categories based on similarity of characteristics. Land classification surveys made by the Water Resources Division of the Department of Natural Resources and Conservation are specifically designed to establish the degree of suitability of land for sustained irrigation farming. The objective is to outline the irrigated land and other areas that have a potential for irrigated agriculture. Because technological advances in irrigation are taken into account, slope and surface topography become less important as rapid expansion of sprinkler irrigation takes place.

The land classification system used in the water resources survey separates the land areas into (1) presently irrigated lands, (2) lands having potential for irrigation which are termed "irrigable," and (3) "non-irrigable" lands which are unsuited for present or future irrigation because of unfavorable characteristics. The term "irrigated lands," is defined as lands on which water is applied by any reasons other than natural precipitation or runoff. The term "irrigated land," as used in this classification, includes land with soils, topography and drainage features that will support sustained irrigated agriculture with proper management, and other necessary conservation practices.

Lands which are classified as "irrigable" are divided into classes on the basis of their relative suitability for irrigation farming. Class 1 represents irrigable land with potentially high productive value, Class 2 represents land of intermediate value, and Class 3 includes land of the lowest value that may be suitable for irrigation.

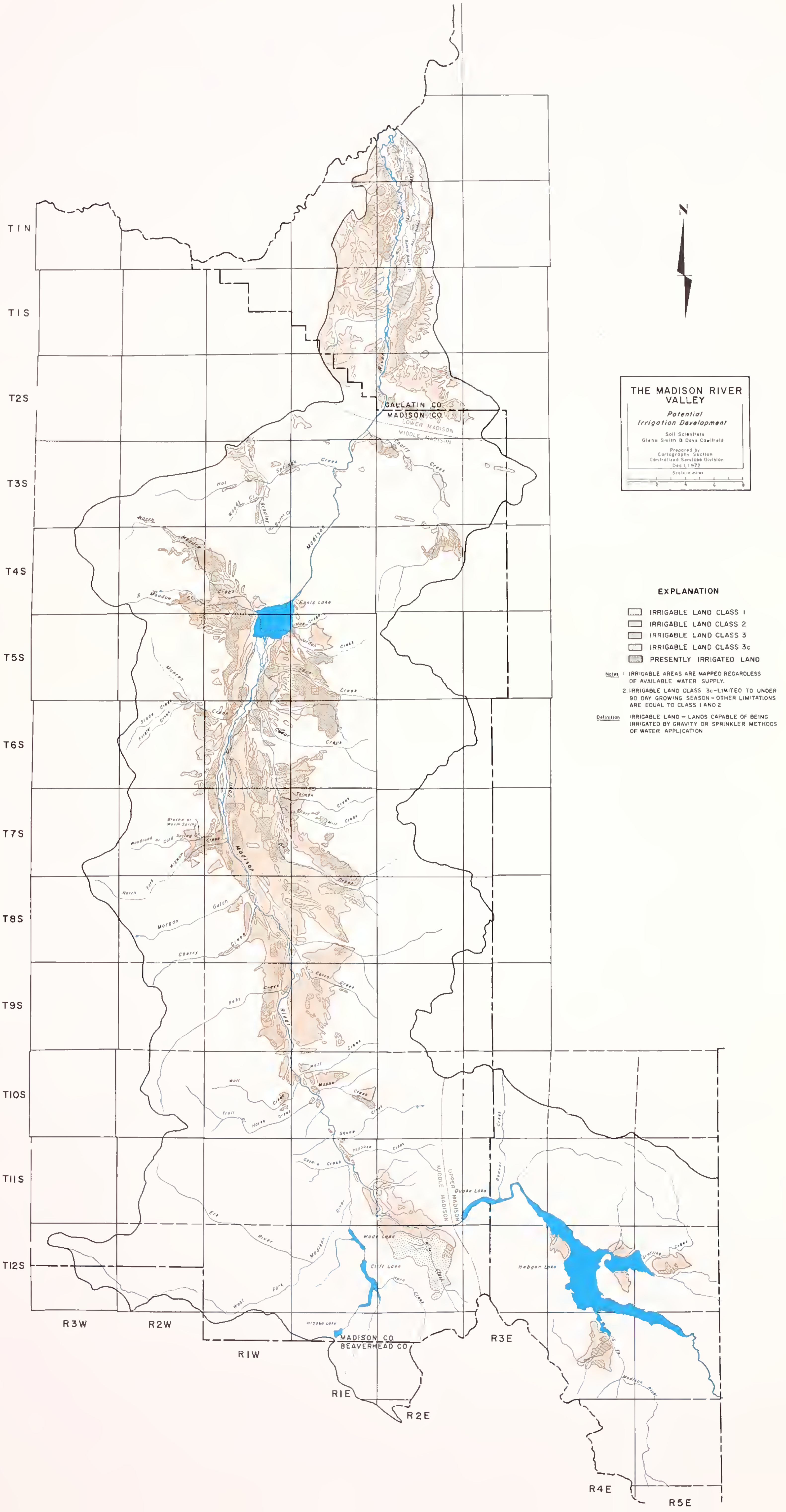
The intensity of this land classification is a general reconnaissance survey. Any future project development should be based on a detailed study to pinpoint the exact location and limits of the land best suited for irrigation.

The Upper Madison Valley

The Upper Madison Valley is a mountainous area which has only 1,200 acres of irrigated native pasture and hayland. The growing season is too short for alfalfa or grain. The potential for irrigation development is so small that it is not significant for this reconnaissance report.

The Middle Madison Valley

The Middle Madison Valley is an elongated inter-mountain basin extending southward from Ennis Lake for about fifty miles and averaging four to twelve miles in width from the foothills on the west to those on the eastern side. The lower areas or valley bottom lands are within the floodplain, and their main use is for livestock grazing. The soils are very rocky and cobbly in the upper reaches of the area from Quake Lake to four miles south of Ennis. The potential irrigation is limited to the areas where the depth of the light



THE MADISON RIVER VALLEY

Potential Irrigation Development

Soil Scientists
Glenn Smith & Dave Coalfield

Prepared by
Cartography Section
Centralized Services Division
Dec 1, 1972

Scale in miles
0 2 4 6 8

EXPLANATION

- ▭ IRRIGABLE LAND CLASS 1
- ▭ IRRIGABLE LAND CLASS 2
- ▭ IRRIGABLE LAND CLASS 3
- ▭ IRRIGABLE LAND CLASS 3c
- ▨ PRESENTLY IRRIGATED LAND

Notes 1. IRRIGABLE AREAS ARE MAPPED REGARDLESS OF AVAILABLE WATER SUPPLY.

2. IRRIGABLE LAND CLASS 3c—LIMITED TO UNDER 90 DAY GROWING SEASON—OTHER LIMITATIONS ARE EQUAL TO CLASS 1 AND 2

Definition IRRIGABLE LAND — LANDS CAPABLE OF BEING IRRIGATED BY GRAVITY OR SPRINKLER METHODS OF WATER APPLICATION

and medium textured soils is great enough to have adequate water holding capacity for good irrigated pasture. The surface cobble will generally prevent hay production.

Within the floodplain of the Madison River, from Ennis Lake upstream to four miles south of Ennis, are wet meadow lands with fairly deep alluvial soil. The meadows are subject to a high water table and periodic flooding from ice gorging. This area is sub-irrigated for part of the growing season, and any improvement in efficiencies, such as sprinklers, would allow better hay and pasture production.

Bench lands border the Madison River floodplains. Elevations above the river increase as the series of benches rises towards the mountains and the river elevation rises towards the upper tributary area and Quake Lake. Tributary streams have washed alluvial deposits over parts of the main river benches, forming alluvial fans; the soils are related to the local geologic formation. Higher elevations above these benches are foothill areas which are adaptable only to livestock grazing.

Irrigated acreages of the Middle Madison are predominantly bench lands, and tributary streams supply the majority of water for the presently irrigated land. The major streams and the number of acres irrigated by each are as follows:

TABLE 12 IRRIGATED ACRES BY TRIBUTARY STREAMS

STREAM	ACRES IRRIGATED
(1) Indian Creek	2,280
(2) Warm Springs or Blaine Spring Creek	1,200
(3) Bear Creek	2,790
(4) Jack Creek	2,000
(5) North Meadow Creek	2,760
(6) South Meadow Creek	1,730
(7) Cedar Creek	3,100
(8) Cherry Creek	1,790
(9) Other smaller tributaries	8,680

Total land irrigated from tributary streams is estimated at 26,300 acres.

The reconnaissance land classification of the Middle Madison area shows 92,268 acres of irrigable land, which is further broken down into 662 acres of Class 1; 16,674 acres of Class 2; and 74,932 acres of Class 3.

Soils of the bench lands are generally relatively shallow above gravel substrata. Irrigable land is that with a soil depth great enough to store water for productive hay and pasture production. There are several areas of deep soil which will allow leveling for gravity irrigation. However, there are also large acreages with scattered cobble and gravel on the surface that are slightly undulating and too shallow to the gravel substrata to allow land leveling. These areas are adaptable to sprinkler irrigation.

The reconnaissance land classification standards recognize land that can be irrigated by sprinklers or gravity as irrigable acreage. The most effective means of water application is by sprinkler. The slightly undulating topography and shallow soils over gravel are irrigable wherever there is adequate soil to support a water holding capacity for good growth of grass and hay. Much of the irrigable land within the Middle Madison subbasin is suitable for sprinkler irrigation only, and the acreage would be greatly decreased if gravity systems alone were considered.

The consumptive use of irrigation water for crop production is the same regardless of the soil. The Soil Conservation Service of the United States Department of Agriculture has computed the crop consumptive use for different climatic regions, using the modified Blaine-Criddle method for arriving at the amount of irrigation water needed for productive growth of the crops within Montana.

The Middle Madison is primarily a livestock producing area. The main agricultural commodity in the area is range for cattle. A successful ranching operation must have a feed base for wintering the breeding herds, and irrigated pasture and hayland are used for this purpose. The estimated irrigated crop percentages for this area, ascertained from the local Soil Conservation Service, are as follows:

Alfalfa	40%
Grain	10%
Irrigated grass mixtures for hay and pasture	50%

The weather records at Ennis were used to establish the amount of water these crops will consume for a full growth and satisfactory yield. The following table from the Soil Conservation Service shows the amount of irrigation water needed by month in order to grow one acre of crop, assuming average rainfall.

TABLE 13 CROPS GROWN IN THE MIDDLE MADISON VALLEY

Irrigation Requirements
Annual Average Rainfall = 10.86 inches

ALFALFA - Acreage: 40% of irrigated area

	Consumptive Water Requirement (Acre Inches Per Acre)	Effective Rainfall (Acre Inches Per Acre)	Irrigation Requirement (Acre Inches Per Acre)	Adjusted For Percent Of Crop Grown in Area
April	---	---	---	---
May	2.05	0.73	1.32	0.528
June	4.69	1.63	3.06	1.224
July	6.21	0.99	5.22	2.088
Aug.	5.02	0.78	4.24	1.696
Sept.	1.30	0.36	0.94	0.376
Oct.	0.00	0.00	0.00	0.000
TOTAL				5.912

GRAIN - Acreage: 10% of irrigated area

April	0.07	0.04	0.03	0.003
May	1.80	1.04	0.76	0.076
June	4.69	1.63	3.06	0.306
July	6.55	1.01	5.54	0.554
Aug.	2.01	0.66	1.35	0.135
Sept.	0.00	0.00	0.00	0.000
Oct.	0.00	0.00	0.00	0.000
TOTAL				1.074

GRASS - Acreage: 50% of irrigated area

April	0.21	0.09	0.12	0.065
May	2.65	1.06	1.59	0.745
June	3.82	1.49	2.33	1.165
July	5.15	0.89	4.26	2.130
Aug.	4.30	0.72	3.58	1.790
Sept.	2.47	0.74	1.73	0.865
Oct.	0.64	0.23	0.41	0.205
Nov.	0.00	0.00	0.00	0.000
TOTAL				6.965

The average amounts of water consumed by crops per month on an irrigated acre of land within the area are as follows:

TABLE 14

IRRIGATION REQUIREMENTS PER ACRE OF LAND IN THE MIDDLE MADISON, ASSUMING AN AVERAGE ACRE IS 40% ALFALFA, 10% GRAIN AND 50% GRASS

Growing Season	Alfalfa	Grain	Grass	Consumptive Irrigation Requirements for One Acre of Irrigated Land in Middle Madison
				(All Figures in Acre-Inches Per Acre)
March	0.000	0.000	---	---
April	0.000	0.003	0.065	0.068
May	0.528	0.076	0.745	1.349
June	1.224	0.306	1.165	2.695
July	2.088	0.554	2.130	4.772
Aug.	1.696	0.135	1.790	3.621
Sept.	0.376	0.000	0.865	1.241
Oct.	0.000	0.000	0.205	0.205
Nov.	0.000	0.000	0.000	0.000
TOTAL				13.951

(Dividing the acre inches by 12 shows that 1.163 acre feet of water is required to irrigate one acre of irrigated land.)

The computed values of net irrigation requirement do not take into account either water application efficiency or water conveyance efficiency, both of which must be considered when determining the total irrigation water requirement for a field or farm. The water efficiencies are generally low in this area. Although actual measurements are not available, general observation of the soil characteristics and irrigation practices on the bench lands indicates a very high water loss. The estimated water conveyance loss to the farms is at least 40%, and the water application loss on the farm is estimated at 60%.

The typical soil profile of bench land soils will generally be a gravelly loam texture to 8 inches. From 8 to 15 inches there will be a pale, brown loam, and from 15 to 20 inches a semi-cemented, high lime content loam, with many rounded gravels. At 20 inches and below are lime crusted gravels and cobbles with very low moisture holding capacity. The moisture holding capacity averages approximately 4.12 inches for crop use. Therefore, frequent light irrigation would generally be the most advantageous. However, there is a tendency to waste water by letting it run on an area for too long a time.

When computing the amount of water required for irrigation to include consideration for these losses, the following table shows the amount of water used for irrigation on the Middle Madison Subbasin.

TABLE 15

IRRIGATION REQUIREMENTS IN ACRE FEET FOR THE MIDDLE MADISON SUBBASIN, BASED ON THE CONSUMPTIVE USE OF 1.163 ACRE FEET PER ACRE

		Column 1	Column 2	Column 3	Column 4
Stream	Acres Irrigated	Diversion Requirements (Acre Feet)	Water Conveyance Loss at 40% Loss (Acre Feet)	Water Application Loss at 60% Loss (Acre Feet)	Consumptive Use of Crops (Acre Feet)
Indian Creek	2,280	11,045	4,418	3,976	2,651
Warm Springs Creek	1,200	5,817	2,327	2,094	1,396
Bear Creek	2,790	13,520	5,408	4,867	3,245
Jack Creek	2,000	9,692	3,877	3,489	2,326
North Meadow Creek	2,760	13,375	5,350	4,815	3,210
South Meadow Creek	1,730	8,383	3,353	3,018	2,012
Cedar Creek	3,100	15,020	6,008	5,407	3,605
Cherry Creek	1,790	8,675	3,470	3,123	2,082
Other Tributaries	8,680	42,062	16,825	15,142	10,095
Madison River	6,430	31,158	12,463	11,217	7,478
TOTAL MIDDLE MADISON SUBBASIN	32,760	158,747	63,499	57,148	38,100

The critical months for crop growth in the area are July and August, when the plants need approximately 60% of the seasonal irrigation requirements. Also, the stream flows are lower at this time. Therefore, conservation of water use at this time would be very desirable, and sprinkler irrigation is one of the most effective ways to conserve water, since the water application losses can be held to 30% and lower depending on wind conditions, temperature, soil characteristics and crop. Assuming a 30% water application loss on the 26,330 acres of irrigated land on tributary streams, a savings of 22,965 A.F. of water could be achieved, and this water could be used to irrigate approximately 13,800 additional acres of irrigable land. The total savings for the Madison River would be derived differently because of return flow adding to the river regardless of the kind of irrigation system.

The lining of canals may cut conveyance water losses by 50%. This could save approximately 31,749 A.F. of water, which could irrigate approximately 19,100 acres of irrigable land by sprinklers.

The sediment from the return flow of irrigation water should not be very high. The shallow, gravelly soils will absorb large quantities of water and allow very little surface runoff, especially if careful water applications are made. The gravel substrata filter out sediment, and return flows are nearly clear. The nitrate, pesticides and chemicals will add some chemicals to return flow, the quantity of which will depend upon the concentration of irrigated acres, the amounts and kinds of applied chemicals, etc. In general, it should be a low chemical amount, and the large amount of flow in the Madison River should dilute the amount to a nearly harmless level.

The potential irrigable land in the Middle Madison classification is based, on the soil, the drainage and the topographic features which are favorable for sustained irrigated agriculture, and the reconnaissance classification is done regardless of water supply to the land. Again, the tabulations for the Middle Madison Area are:

Irrigable Class 1 land	662	
Irrigable Class 2 land	16,674	
Irrigable Class 3 land	74,932	
Totaling	92,268	irrigable acres of land

Any breakdown into stream drainage would be difficult, for the land classification is being conducted regardless of water supply. The rounded figure of 100,000 irrigable acres would require approximately 116,300 A.F. of irrigation water for crop consumptive use.

The present return flows into the Madison from the irrigation of the 32,760 acres of land can be estimated at approximately 67% of the total water not consumed by the plants, or approximately 80,800 A.F. The use of water for the presently irrigated land should not hinder the fishing from the Madison. However, the full irrigation of potential irrigable land may lower its flow. A figure for irrigating all potential irrigable land would be misleading, because the water supply for these lands has not been determined.

The Lower Madison Valley

The Lower Madison Valley extends twenty-one miles upstream from the mouth of the Madison River. The valley varies in width from one to two and one-half miles.

Most of the area consists of low terraces and flood plains which generally have shallow soils over gravel. The presently irrigated lands are generally within the valley bottom lands of the Madison River. Irrigated areas above the river wash gravels are an exception, and here the soils are moderately deep with a light brown silt loam surface underlain in many places by a yellowish-gray silty clay, which is streaked with calcium carbonate and other salts. The entire valley area is subject to a high ground-water table, which is a factor contributing to large spots of alkali soils. There are small tracts of irrigable land that may be developed by sprinkler or gravity irrigation.

The 10,250 acres presently irrigated in the Lower Madison area include 7,750 acres of valley bottom lands, which are mainly pasture land. The remaining 2,500 irrigated acres are on recently developed sprinkler irrigated areas of bench lands.

The percentages of irrigated crop acreage in the Lower Madison are approximately:

Alfalfa-grass mixture for hay	30%
Grain	5%
Irrigated Grassland	65%

The consumptive irrigation requirements were determined by using the Whitehall weather records obtained from the Soil Conservation Service.

TABLE 16

IRRIGATION REQUIREMENTS FOR CROPS GROWN IN LOWER MADISON
ANNUAL AVERAGE RAINFALL = 9.64 INCHES

ALFALFA - Acreage: 30% of irrigated area

	Consumptive Water Requirement (Acre Inches Per Acre)	Effective Rainfall (Acre Inches Per Acre)	Irrigation Requirement (Acre Inches Per Acre)	Adjusted For Percent of Crop Grown in Area
April	0.00	---	---	---
May	2.48	0.94	1.54	.46
June	4.66	1.57	3.09	.93
July	6.61	0.80	5.81	1.74
Aug.	5.53	0.65	4.88	1.46
Sept.	2.08	0.56	1.52	.46
Oct.	0.00	0.00	0.00	.00
TOTAL				5.05

Table 16 Cont.

GRAIN - Acreage: 5% of irrigated area

	Consumptive Water Requirement (Acre Inches Per Acre)	Effective Rainfall (Acre Inches Per Acre)	Irrigation Requirement (Acre Inches Per Acre)	Adjusted For Percent of Crop Grown in Area
April	0.16	0.08	0.08	.01
May	2.11	1.18	0.93	.05
June	4.87	1.59	3.28	.16
July	6.58	0.80	5.78	.29
Aug.	1.68	0.49	1.19	.06
Sept.	0.00	0.00	0.00	.00
Oct.	0.00	0.00	0.00	.00
TOTAL				.57

GRASS - Acreage: 65% of irrigated area

	Consumptive Water Requirement (Acre Inches Per Acre)	Effective Rainfall (Acre Inches Per Acre)	Irrigation Requirement (Acre Inches Per Acre)	Adjusted For Percent of Crop Grown in Area
April	0.42	0.14	0.28	.18
May	2.77	1.20	1.57	1.02
June	3.79	1.47	2.32	1.51
July	5.48	0.73	4.75	3.09
Aug.	4.73	0.61	4.12	2.68
Sept.	2.61	0.76	1.85	1.20
Oct.	0.66	0.16	0.50	.33
Nov.	0.00	0.00	0.00	.00
TOTAL				10.01

A summarization of the adjusted percentage of crops grown in the area indicates the consumptive irrigation requirement for one acre of irrigated land in the Lower Madison Valley to be 1.30 acre feet.

The overall efficiency of water application and water conveyance is very low due to shallow gravelly soils, field application of water, and unlined canals. The water application losses are 50% to 70%, and the water conveyance losses are about 40% to 50%. The average losses of water are shown in Table 17.

TABLE 17

IRRIGATION REQUIREMENTS IN ACRE FEET FOR THE LOWER MADISON SUBBASIN BASED ON THE CONSUMPTIVE USE OF 1.30 ACRE FEET PER ACRE

	Acres Irrigated	Diversion Requirements (Acre Feet)	Water Conveyance Loss at 40% Loss (Acre Feet)	Water Application Loss at 60% Loss (Acre Feet)	Consumptive Use of Crops (Acre Feet)
Gravity Irrigated Bottom Lands	7,750	41,979	16,791	15,113 Water Application Loss at 30%	10,075
Sprinkler Irrigated Bench Lands	2,500	7,737	3,095	1,392	3,250
TOTAL LOWER MADISON SUBBASIN	10,250	49,716	19,886	16,505	13,325

As in the Middle Madison Valley the critical months for crop growth in the area are July and August. Conservation of water use at this time would be very desirable. Sprinkler irrigation of the valley bottom lands, which would conserve water, would also help to alleviate the high ground-water condition. The productivity of the crops may be increased enough to offset costs. However, the present soil and seepage characteristics should be analyzed before the expenditure of large amounts for sprinklers.

There are 34,754 acres of irrigable land within the Lower Madison Valley. The majority of the acreage is on the bench lands that divide the Madison and the Willow Creek drainages. The continuing development of irrigation in the bench lands and bottom lands by the ranchers is anticipated, and, if all 34,754 acres of irrigable land are eventually irrigated, approximately 45,180 A.F. of irrigation water would be required for crop consumptive use.

The annual return flows into the Lower Madison from the irrigation of the 10,250 acres of land presently irrigated can be estimated at approximately 67% of the total water not consumed by the plants. This would be approximately 24,380 A.F.

Summary

1. Irrigation is the largest water use in the Madison River Basin. However, the main flow of the Madison is not the principal source

of water supply. The tributary streams are furnishing irrigation water for 26,330 of the 43,010 acres of irrigated land.

2. The percentage breakdown for irrigated crops grown in the Madison Basin is:

	Middle	Lower
Grass for irrigated pasture and hayland	50%	65%
Alfalfa	40%	30%
Grain	10%	5%

The amount of water required by crops for full irrigation of one acre of land in the Middle Madison Valley is 1.163 acre feet for each irrigation season, and that for the Lower Madison is 1.3 acre feet. These amounts are derived by using the Soil Conservation Service's Modified Blaine-Criddle Method, which utilizes weather records. The calculations for the Middle Madison are based on the Ennis weather records, and those for the Lower Madison are based on Whitehall weather records.

The total amount of irrigation water required by crops for full irrigation of 43,010 acres is 51,425 A.F. per year.

The present irrigation efficiency for both the Madison River and tributaries is very low. The estimated water loss of on-farm application is 60%, and the water conveyance loss from canals to farm is 40%. The main application losses are due to irrigation of relatively shallow soils (averaging 20 inches over gravel) and inefficient irrigation practices. The conservation of water should be the highest agricultural priority if expansion of irrigation is needed.

If exclusive sprinkler irrigation were to become a reality, the reduction of farm water loss to 30% would provide enough water to irrigate another 13,800 acres of land from the tributary streams in the Middle Madison, assuming a full water supply available in such streams. This is not always the case. But even if only a partial water supply were available, sprinklers would allow a large increase in irrigation.

The lining of canals and farm laterals could decrease water conveyance loss to 20%. This would save 31,749 A.F. of water annually, or enough to irrigate 19,100 additional acres in the Middle Madison. Again, a full supply of water is assumed, but this is not always the case. If only a partial water supply were available, the number of irrigated acres could be increased or higher yields returned on presently irrigated acres.

The upland bench areas of the Lower Madison are being irrigated by sprinklers. Detailed land classification and drainage investigations should be conducted on the valley bottom lands before water savings by sprinklers and ditch lining are estimated.

3. The runoff from present and future irrigation should be of a good quality because of the soil characteristic of gravelly loam over gravel substrata. The gravel should filter out much sediment, and the light to medium gravelly, shallow soils minimize surface waste runoff. About 67% of irrigation runoff should return to the river.

4. Research as to costs of sprinkler irrigation and canal lining, cooperation among landowners, and wind velocity in relationship to sprinkler irrigation efficiency should be done in the Middle Madison Area before large irrigation expansion is considered.

5. In some irrigated areas pipe laterals are used, and in still others open canals with linings of asphalt, plastic, or concrete for protection against high canal losses are used. The determination of methods to avoid canal losses should be through cost analysis and meetings among the landowners.

6. The 16,650 acres of irrigated land receiving water from the Madison River will consume an estimated 20,803 A.F. of water per year for crops. Also, approximately 67% of the runoff from land irrigated by the tributaries will return to the Madison River. Development of high intensity recreational areas near Ennis should not be hindered by present irrigation. The development of potential irrigable land also may be done without detriment to recreational use of the river if careful water management is practiced.

7. In studies to explore the possibility of dams on tributaries of the Madison River, numerous sites have been proposed which could contribute water storage for irrigation. These proposals are discussed briefly in a later section of this report.

8. The expansion of irrigation onto the bench lands of the Lower Madison is possible and is being considered by some of the present landowners.

9. A detailed land classification or soil survey should be done before any large additional irrigation is planned in the Lower Madison valley bottom lands, because the high water table and alkaline soil areas may limit expansion.

WATER AVAILABILITY IN THE MIDDLE MADISON SUBBASIN

Introduction

The potential for increased irrigation in the Madison Valley can be realized only if an adequate water supply is available. Although sufficient water is certainly available in the Madison River, legal and environmental constraints may preclude its use for increased irrigation. It thus appears, particularly for the Middle Madison area, that the bulk of additional irrigation waters would have to be supplied by tributary streams. Since all of the tributary streams presently supplying irrigation waters have been adjudicated, it is evident that seasonal water shortages do presently occur. It may, nevertheless, be possible to store and regulate tributary flows to provide an adequate water supply for increased as well as currently irrigated acreage. The following study represents an attempt to estimate this potential for only the Middle Madison area.

Flow Estimates

At present there is a complete lack of historical flow record on the Middle Madison tributaries. In order to make reasonable estimates of flow in ungaged areas, information from geographically similar streams with record must be utilized. For this study multiple-regression equations derived by the U.S. Geological Survey were used to estimate average annual runoff and mean monthly runoff for selected streams in the Middle Madison area. In order to make meaningful comparisons between irrigation requirements and water supply, only those tributaries presently irrigating significant acreages were considered.

In all cases, the contributing drainage areas were considered to be only the mountainous areas above 6,000 feet in elevation. Some surface runoff from bench land areas is probably collected by these streams enroute downstream, but this was considered negligible.

The following table shows drainage area, estimated present diversion requirements, mean annual flow estimates, and confidence limits for the mean flow estimates for each stream considered.

TABLE 18 TRIBUTARY CHARACTERISTICS

Stream	Drainage area sq. miles	Present Diversion Requirements A.F./yr	Est. Mean Flow A.F./yr	Confidence Limits for Mean Flow A.F./yr
Bear Cr.	34.7	13,500	28,200	20,600-35,700
Cedar Cr.	15.9	15,000	13,400	9,800-17,100
Cherry Cr.	20.8	8,700	17,300	13,100-21,400
Indian Cr.	50.3	11,000	35,500	25,900-45,000
Jack Cr.	51.8	9,700	41,200	30,100-52,300
N. Meadow Cr.	18.2	13,400	13,200	9,600-16,800
S. Meadow Cr.	8.85	8,400	7,300	5,300- 9,300

The confidence limits in the above table indicate the level of accuracy of the mean flow estimate. In general, there is about a 30% chance that the true mean annual flow of any of these streams lies outside the flow range indicated. This level of accuracy is about equivalent to that obtained from a mean flow estimate based on two to three years of actual flow record.

Assuming that the lower figure in the confidence limit column represents a conservative mean flow estimate, the above table indicates that an adequate water supply apparently exists on Bear Creek, Cherry Creek, Indian Creek, and Jack Creek. It does not appear that sufficient water is available in the other tributary streams to meet even the present irrigation requirements.

To assess the possible need for storage on the above named tributaries, it is necessary to compare seasonal variations in water requirements with the seasonal variations in streamflows. The following table shows the estimated monthly flow versus the estimated present monthly diversion requirement.

TABLE 19

ESTIMATED MONTHLY FLOW VERSUS DIVERSION REQUIREMENTS

Bear Creek

Month	Diversion Requirement (Acre Feet)	Average Runoff (Acre Feet)
April	65	1,440
May	1,310	7,820
June	2,610	8,450
July	4,625	2,690
Aug.	3,510	1,210
Sept.	1,200	890
Oct.	200	1,120
TOTAL	13,520	23,620

Cherry Creek

Month	Diversion Requirement (Acre Feet)	Average Runoff (Acre Feet)
April	40	910
May	840	4,760
June	1,675	5,140
July	2,970	1,630
Aug.	2,255	740
Sept.	770	540
Oct.	125	660
TOTAL	8,675	14,380

Indian Creek

Month	Diversion Requirement (Acre Feet)	Average Runoff (Acre Feet)
April	55	1,720
May	1,070	10,130
June	2,135	11,100
July	3,780	3,590
Aug.	2,865	1,950
Sept.	980	1,410
Oct.	160	1,470
TOTAL	11,045	31,370

Jack Creek

Month	Diversion Requirement (Acre Feet)	Average Runoff (Acre Feet)
April	45	2,200
May	940	11,450
June	1,875	12,400
July	3,315	3,940
Aug.	2,515	1,820
Sept.	860	1,340
Oct.	140	1,500
TOTAL	9,690	34,650

Table 19 shows that the requirement exceeds the supply on all streams during the month of August. Indian Creek also experiences a shortage in July; Cherry Creek and Bear Creek also experience shortages during July and September.

Assuming that instream flow requirements for fish and wildlife are 10% of the maximum monthly flow, and further assuming that only spring flood waters are stored, the table below shows the estimated additional acreage that could be irrigated from the four tributaries.

TABLE 20 POTENTIAL FOR INCREASED IRRIGATION

Stream	Present Irrigated Acreage	Additional Irrigated Acreage Possible With Storage
Bear Creek	2,790	800
Cherry Creek	1,790	400
Indian Creek	2,280	2,500
Jack Creek	2,200	3,200

It would thus appear that increased irrigation through storage is a definite possibility on Indian Creek and Jack Creek. The installation of storage structures on Bear Creek and Cherry Creek would certainly improve present irrigation efficiency, but it is doubtful whether projects could be justified on the small increase in irrigated acreage.

Conclusions

As was mentioned previously, this study considers only selected tributary streams in the Middle Madison region. No attempt was made to assess water availability on the Madison River itself or on tributary streams not presently irrigating significant acreages.

From the data available, it appears that Indian Creek and Jack Creek offer the best potential for increased irrigation. Storage structures are a necessity, however, since both of these streams presently have supply shortages during late summer.

Several possible project sites on Madison River tributaries have been identified over the years, but none have been subjected to recent investigation. This study indicates that further, detailed studies, particularly on Jack Creek and Indian Creek, may be warranted. Optimal beneficial use of the Madison Valley water supply will require compromises between competing demands -- most notably recreation and irrigation. Better and more complete use of tributary streams for irrigation could help ease this conflict on the Madison River itself.

It appears that increases in irrigated acreage may be accomplished by private enterprise more readily than by federal projects.

TABLE 21

POTENTIAL STORAGE SITES

SITE NAME	STREAM NAME	LOCATION			DRAINAGE AREA	DAM		RESERVOIR	
		Twp	Rge	Sec.	Sq. Miles	Height in Feet	Crest Length Feet	Normal Pool Area-Acres	Storage Acre Feet
Anceney	Cherry Creek	3S	2E	6	61	100	--	798	40,400
Bridger Reservoir	Bridger Creek	1S	6E	35	60	60	--	240	6,530
Cherry Creek	Cherry Creek	3S	1E	11	65	25	400	--	--
Diamond	Jack Creek	5S	1E	35	50	145	--	116	5,810
Ennis *	Madison River	4S	1E	20	2,190	109	--	10,504	588,100
Jack	Jack Creek	6S	2E	4	26	100	--	106	3,580
Lower Canyon	Madison River	3S	1E	11	--	20	500	--	--
Madison Canal	Madison River	10S	1E	28	--	--	--	--	--
Madison Lakes	---	--	--	--	--	--	--	--	--
Madison Reservoir	Madison River	2S	1E	25	2,390	225	--	5,915	772,000
Meadow	Meadow Creek	4S	1W	19	40	100	--	159	7,560
Metzel	W.F. Madison River	12S	2W	30	13	115	--	136	4,000
Moore's Creek	Moore's Creek	5S	2W	36	--	--	--	--	--
Norris	Hot Springs Creek	3S	1W	16	22	80	--	264	8,260
Ruby Creek Storage	Ruby Creek	9S	1W	--	--	--	--	--	--
Sureshot	Meadow Creek	3S	2W	32	17	80	--	72	2,630
W.F. Madison Diversion	W.F. Madison River	13S	1W	6	--	--	--	--	--

* Proposed Enlargement of Existing Structure

POTENTIAL PROJECTS

Numerous project proposals have been either identified or investigated by various agencies over the years, and the following table lists those which may be well known in the Madison Valley.

Of the seventeen proposals, all are for the purpose of irrigation except the multi-purpose Lower Canyon site of the Corps of Engineers. The once viable Upper Canyon site, also a Corps proposal, is now inundated by Earthquake Lake. Twelve of the sites are for tributary storage, four are proposed on the River itself, and one is at an undetermined location. All sites but Madison Canal, Madison Lakes, Moore's Creek, West Fork Madison Diversion, and the previously mentioned Lower Canyon site are Bureau of Reclamation proposals mentioned over the years in various reports. The other projects are early Water Resources Division proposals and often originated from very little detailed information.

These projects have not been subjected to recent investigation, and a closer inspection may prove them beneficial in providing additional water and land resource development.

RECREATION

Recreational opportunities are extensive in the Madison River Basin, and from all indications the growth of associated activities seems assured. Important factors relating to this anticipated growth are many, with some of the more critical ones being a high quality environment, the lack of a population concentration in the Basin, better access created through an improved highway system, the Basin's proximity to other high quality recreational opportunities, and the reputation of the Madison River as one of the nation's highest quality trout fisheries.

In the past, residents of the valley along with other residents of southwestern Montana were the vast majority of recreational users in the valley. However, recent studies show that more and more out-of-staters, especially those from the West Coast, are using the facilities and opportunities in the Basin. If the national trend toward more leisure time and increased mobility continues, it should be expected that more and more out-of-state residents will be visiting the Madison River Basin for recreational purposes.

Current Situation

Fishing is one of the major recreational attractions of the area. The Madison River, designated by the Montana Department of Fish and Game as a blue ribbon fishing stream, is renowned throughout the United States for its abundant and trophy-sized fish. An example of both the number and pounds of fish found in the Madison River can best be shown by the results of a study done by the Department of Fish and Game in October 1970. It was estimated that in a four mile section of the river, fish numbers approached 15,104 trout weighing 11,057 lbs. A further breakdown showed that for every 1,000 feet of river there were 703 trout with a total weight of 514 lbs.

Access to the Madison River for purposes of fishing, floating, picnicking, sightseeing and other recreational pursuits is provided by numerous sites administered by the Montana Department of Fish and Game. Access is also available at recreational areas administered by the Bureau of Land Management and via various county and private roads not directly associated with recreational developments.

According to the Montana Department of Fish and Game, although the present use of the river is considered heavy, especially in association with fishing activities, the fishery itself, in both quantity and reproductive capacity, could stand even heavier pressure without jeopardizing the resource. It appears that in the future the limiting factor will be the use of the land adjoining the river rather than the capacity of the fishery. This fact becomes even more significant in light of the estimated 15,000 fisherman days per month spent on the Madison River during the four summer months.

Most of the present lake and reservoir sites in the study area also offer good to excellent fishing. Hebgen Lake receives moderate to heavy pressure during the summer months. Ennis Lake is not able to support the fishery that Hebgen does because of siltation caused by deposition of materials originating from the 1959 earthquake.

Rainbow and cutthroat trout are the only fish planted on a "put-and-take" basis in impoundments, while the rainbow is also used to supplement the fishing in the Madison River. The predominate fish in the Madison River is the brown trout. No artifical planting of this species is needed, as the fish is well suited to the habitat and propagates itself rapidly. Whitefish also abound in the Madison.

Recreational visitors utilize parts of the valley, especially National Forest lands, for hunting. Elk and deer attract a large amount of hunting activity, with limited hunting available for mountain goat, mountain sheep, moose, and antelope. Upland game birds include blue, franklin, ruffed and sage grouse, grey partridge and pheasant.

Sightseeing, historic trail tracing, historic site exploration, photography, artifact hunting and rock hunting are recreational activities which have been increasing in popularity, especially with tourists passing through the study area on their way to and from Yellowstone National Park, Virginia City and Alder, or Lewis and Clark Caverns. Picnicking, a form of passive recreation, is an activity mainly engaged in by the local people. Picnic facilities concentrated in recreational areas around Ennis receive considerable pressure. There are indications that picnicking activities are increasing, especially in conjunction with transient vacationers.

A new winter activity which has been gaining popularity rapidly is snowmobiling. Snowmobiling has been basically a sport of the local people. However, because of extensive open areas in the Gravelly Mountain Range, dry snow conditions and clear winter weather, many non-local people are also beginning to use this area.

At the present time, ski facilities are not available within the planning area. In previous years, however, limited ski facilities were provided near Jack Creek in the eastern part of the Basin. Accessibility to the ski facilities located at the Big Sky complex will be discussed.

Dude ranching is becoming more popular in the study area, with three ranches in the valley providing activities for guests.

Vacation and cabin development has been gaining momentum. In the past, owners of cabins in the valley were limited to residents of Bozeman or Butte. Recently the ownership trend in vacation homes has been changing to include more out-of-state residents and larger organized developments.

There are two specific larger scale developments in or bordering the study area. One of these is the Shining Mountains Land Development Project. The plans for this site call for the development of over 9,000 acres of land southwest of Ennis. There are to be approximately 600 individual land parcels, with each tract being five acres or larger in size. At the full development stage the Shining Mountains Project could add over 1,500 people to the summer population of this area, and, as a result of an increased population base, a considerable impact could occur on the recreational resources of the area.

The other major recreational development that will exert an impact on the area is the Big Sky complex located in Gallatin County and separated from the Madison Basin by the Spanish Peaks mountain range. The degree of impact that this complex will have on the Basin is dependent upon the proposed Jack Creek road, which would connect the site with Highway 287. It has been estimated that, at the full development stage, the potential will exist for a daily visitation of 10,000 to 12,000 people to this year-round vacation site. With the proposed road, camping and recreational facilities in the study area would conceivably receive considerable pressure resulting from an overflow of persons not able to obtain reservations or afford accommodations at Big Sky.

Changes

Recreation in the Madison Basin is a dynamic consideration. The use of land within the Basin for recreational purposes is increasing rapidly. In the past, as previously mentioned, residents of the valley were the major users of recreational facilities and the surrounding National Forest. Recently, however, an increasing number of people have been coming from non-local areas, including other states. Demand for river-front cabin site developments is increasing, and this type of activity ultimately closes much land to public use. The ownership trend of vacation homes has been changing to include more out-of-state residents and people preparing for retirement.

One of the management alternatives that has been suggested for the Madison River is the inclusion of the river in the National Wild and Scenic River System. Preliminary studies conducted by the planning section of the Water Resources Division, Department of Natural Resources and Conservation have shown that, although the majority of the Madison could not qualify for a wild or scenic designation, it could meet the criteria for a recreational river status.

The management objectives of recreational rivers are to protect and enhance the existing recreational values of the area. Campgrounds and picnic areas may be established in close proximity to the river, although recreational river classification does not require extensive recreational developments. Recreational facilities may still be kept to a minimum with visitor services provided outside the river area. It is not a requirement of the Act to acquire easements along the entire stretch of the river.

Future construction of impoundments and diversions, straightening, riprapping, and other modification of the waterway or adjacent land would not be permitted except in instances where such developments would not have a direct and adverse effect on the river.

In general, a wide range of agricultural, water management and other practices could be compatible with the primary objectives of a recreational river area, providing such practices are carried on in such a manner so as not to have a substantial adverse effect on the river. In other words, the Madison River could become a recreational river, and, at the same time, additional irrigation projects could be developed.

The following two pages list the attributes and management objectives of the wild, scenic, and recreational river classifications of the National Wild and Scenic River Act (P.L. 90-542).

Attributes and management objectives of the three river classifications for inclusion in the National Wild and Scenic River System

ATTRIBUTES

Wild	Scenic	Recreation
1. Free-flowing. Low dams, diversion works or other minor structures which do not inundate the natural riverbank may not bar consideration as wild. Future construction restricted.	1. Free-flowing. Low dams, diversion works or other minor structures which do not inundate the natural riverbank may not bar consideration. Future construction restricted.	1. May have undergone some impoundment or diversion in the past. Water should not have characteristics of an impoundment for any significant distance. Future construction restricted.
2. Generally inaccessible by road. One or two inconspicuous roads to the area may be permissible.	2. Accessible by roads which may occasionally bridge the river area. Short stretches of conspicuous or or longer stretches of inconspicuous and well-screened roads or railroads paralleling river area may be permitted.	2. Readily accessible, with likelihood of paralleling roads or railroads along river banks and bridge crossings.
3. Shorelines essentially primative. One or two inconspicous dwellings and land devoted to production of hay may be permitted. Water shed natural-like in appearance.	3. Shoreline largely primitive. Small communities limited to short reaches of total area. Agricultural practices which do not adversely affect river area may be permitted.	3. Shoreline may be extensively developed.
4. Water quality meets minimum criteria for primary contact recreation except where such criteria would be exceeded by natural background conditions and esthetics 1/ and capable of supporting propagation of aquatic life normally adapted to habitat of the stream.	4. Water quality should meet minimum criteria for desired types of recreation except where such criteria would be exceeded by natural background conditions and esthetics 1/ and capable of supporting propagation of aquatic life normally adapted to habitat of the stream, or is capable of and is being restored to that quality.	4. Water quality should meet minimum criteria for desired types of recreation except where such criteria would be exceeded by natural background conditions and esthetics 1/ and capable of supporting propagation of aquatic life normally adapted to habitat of the stream or is capable of and is being restored to that quality.

1/ Federal Water Pollution Control Administration's Water Quality Criteria, April 1, 1968.
February 1970
Source: GPO 889-442

MANAGEMENT OBJECTIVES

Wild	Scenic	Recreation
1. Limited motorized land travel in area.	1. Motorized vehicles allowed on land area.	1. Optimum accessibility by motorized vehicle.
2. No unharmonious or new habitations or improvements permitted.	2. No unharmonious improvements and few habitations permitted.	2. May be densely settled in places.
3. Only primitive-type public use provided.	3. Limited modern screened public use facilities permitted, i.e. campgrounds, visitor centers, etc.	3. Public use areas may be in close proximity to river.
4. New structures and improvement of old ones prohibited if not in keeping with overall objectives.	4. Some new facilities allowed, such as unobtrusive marinas.	4. New structures allowed for both habitation and for intensive recreation use.
5. Unobtrusive fences, gauging stations and other management facilities may be permitted if no significant adverse effect on natural character of area.	5. Unobtrusive fences, gauging stations and other management facilities may be permitted if no significant adverse effect on natural character of area.	5. Management practice facilities permitted.
6. Limited range of agriculture and other resource uses permitted.	6. Wide range of agriculture and other resources uses may be permitted.	6. Full range of agriculture and other resource uses may be permitted.

The impact of recreation and tourism is playing an ever larger role in the economy of the valley, and it is estimated that a high percentage of the sales of such businesses as motels, gas stations, and eating establishments is directly related to recreation and tourism.

The ultimate role of recreation in the Madison Basin is going to be the combined result of many public and private decisions. It is apparent there are demands that more land and other natural resources be allocated to recreation and tourism. Such decisions may mean taking land away from other present and potential uses. Some private developments will mean diminished public access.

The impacts of new road construction, changes in National Park Management, and seasonal recreational activities are all likely to effect changes in the use of the resource base.

MINERALS

The principal metals within the Basin are native gold and lesser amounts of silver, lead, manganese, copper, chromium, and molybdenum. Sedimentary iron formation deposits are mixtures of magnetite, hemalite, and limonite. Numerous nonmetallic mineral commodities occur in this area, including pumice, asbestor, kyanite, sillimanite, mica, feldspar, corundum, phosphate rock, gypsum, sand and gravel, and talc. Of this group, sand and gravel and talc will probably be the most economically important within the foreseeable future.

Mining processes within the Basin include underground, open pit, and placer operations. Talc, now being produced by the Mountain Talc (Yellowstone) mine south of Ennis at Johnny Gulch is trucked to Three Forks and shipped by rail to Grand Island, Nebraska, for processing. Sand and gravel deposits along the Madison River, easily accessible, often are also developed.

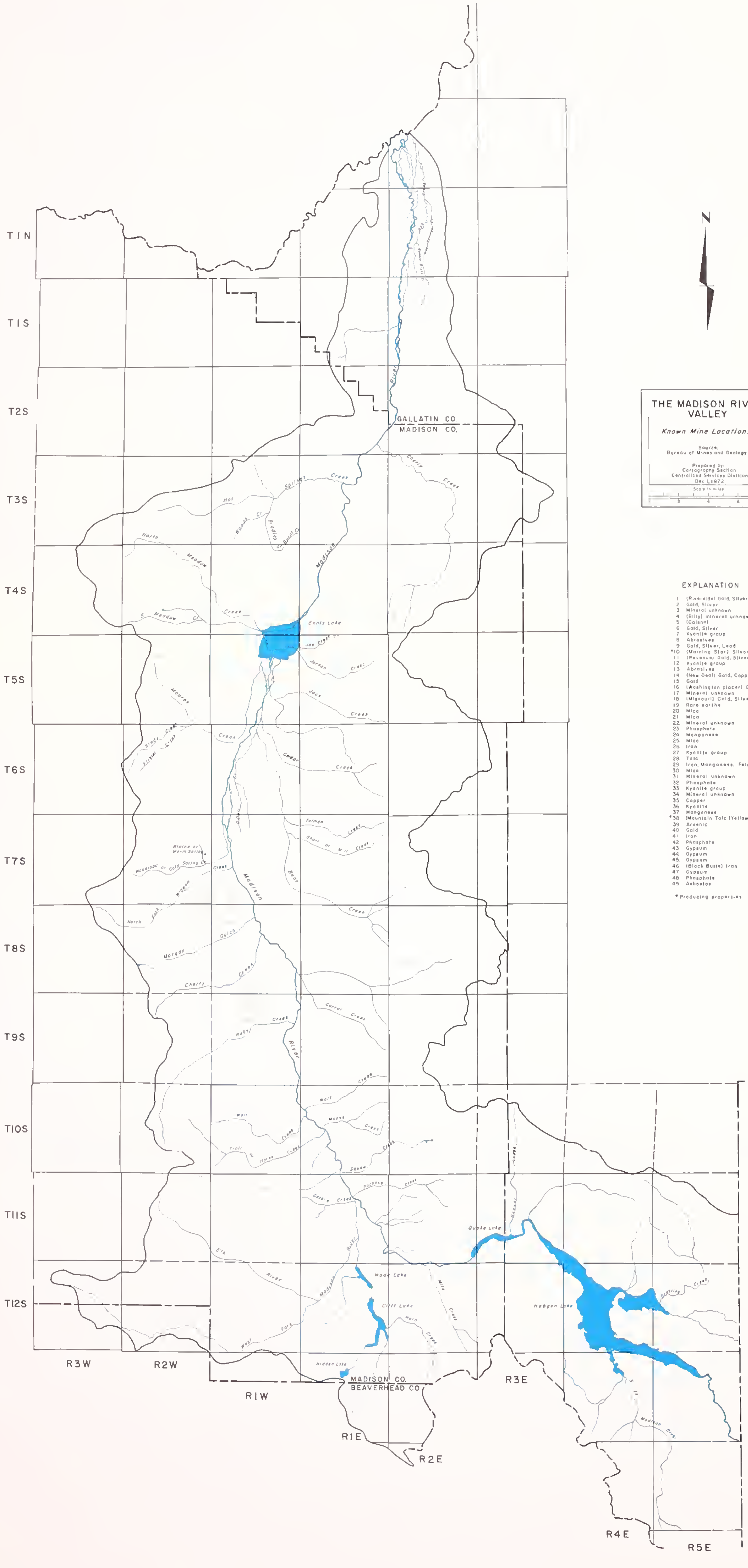
Madison County probably has the nation's largest principal supply of talc, and an increase in production may be expected. Water needs for processing talc will grow, but processing should not constitute a major use of water in the area because recycling reduces the requirement for make-up water.

It is difficult to project the iron ore production, if iron is ever produced in the Madison drainage area. Should it be produced, concentrated, and pelletized, about 3,600 gallons per minute would presumably be required for process water. If the water is recycled, make-up requirements would be less than half the total requirements.

The mineral potential within the Madison drainage is good, and, according to the Montana Bureau of Mines and Geology, it is reasonable to believe that new deposits of metals and nonmetals will be discovered.

Short-term fluctuations in metal prices are almost unpredictable, because so many factors are involved. During the last decade, however, the overall trend has been upward. As the increasing population requires more manufactured goods, the cost of metals and nonmetals will inevitably increase because of the necessity of reducing environmental impact and the diminution of ore reserves.

Since Congress removed the $35.00 per ounce ceiling on gold, the price has steadily risen to approximately $65.00 per ounce in October of 1972. Silver is now fluctuating within a price range of $1.70 to $1.85 per ounce. It is predicted that prices will have to increase to about $100.00 an ounce for gold and $2.50 an ounce for silver before development of known reserves of precious metals in the Basin will become significant. If federal legislation were enacted to allow American citizens to legally hold gold bullion and unrestricted amounts of placer gold, a fairly rapid rise in the price of gold to $150.00 or $175.00 an ounce would not be unreasonable.



THE MADISON RIVER VALLEY

Known Mine Locations

Source:
Bureau of Mines and Geology

Prepared by:
Cartography Section
Centralized Services Division
Dec 1, 1972

Scale in miles
0 2 4 6 8

EXPLANATION

1 (Riverside) Gold, Silver
2 Gold, Silver
3 Mineral unknown
4 (Billy) mineral unknown
5 (Galena)
6 Gold, Silver
7 Kyanite group
8 Abrasives
9 Gold, Silver, Lead
*10 (Morning Star) Silver, Zinc
11 (Revenue) Gold, Silver
12 Kyanite group
13 Abrasives
14 (New Deal) Gold, Copper, Lead, Zinc
15 Gold
16 (Washington placer) Gold
17 Mineral unknown
18 (Missouri) Gold, Silver
19 Rare earths
20 Mica
21 Mica
22 Mineral unknown
23 Phosphate
24 Manganese
25 Mica
26 Iron
27 Kyanite group
28 Talc
29 Iron, Manganese, Feldspar, Kyanite group
30 Mica
31 Mineral unknown
32 Phosphate
33 Kyanite group
34 Mineral unknown
35 Copper
36 Kyanite
37 Manganese
*38 (Mountain Talc (Yellowstone)) Talc
39 Arsenic
40 Gold
41 Iron
42 Phosphate
43 Gypsum
44 Gypsum
45 Gypsum
46 (Black Butte) Iron
47 Gypsum
48 Phosphate
49 Asbestos

* Producing properties

Nonmetal prices are more stable, and increased prices are more closely related to annual inflationary costs and new uses developed through research.

The Burlington Northern's Red Bluff branch line is currently (January 1973) in operation; however, a petition to drop this service is under consideration. The mining industry is heavily dependent on rail transportation of ore concentrates and nonmetallic products. The present unsettled status of railroad transportation facilities apparently discourages the development of mineral deposits.

Sufficient water is essential for mining and milling operations. Placer operations require considerable water, but it can be recirculated if the occasion demands. Water would be needed for the washing of sand and gravel, and it may be required for talc if it is washed prior to further processing. In spiral classification of vermiculite ore, water is used to concentrate different grades of products.

It is believed that water requirements could be met by development of springs or wells to utilize subsurface water. A hydrologist should examine each area to ascertain the quantity and quality of water necessary for a small to medium operation, but sufficient water for the small mine operations in the Basin probably could be developed.

CONCLUSION

This report should not be considered a plan for the Madison Valley. It is, as its title implies, merely a survey of the water and related resources of the Basin.

Many alternatives are available to the people of the study area. Some are mutually exclusive, but others are compatible to some degree. For instance, agriculture has been the dominate economic force in the Basin. Recreation will play an increasingly important role in the future. It appears that these two types of activity need not be mutually exclusive. With proper planning, both can prosper within the Basin, benefiting the economy through diversity as well as total income. The relationship between agriculture and recreation is used only as an example and should not be the only factor considered in planning for the Basin.

The future of the Madison lies in the hands of the people. The next few years will be exciting, because decisions will have to be made concerning the development or non-development of the area's resources. Without comprehensive planning for land and water use management, the door is opened for uncontrolled growth and development, which often ignores consideration of the resources' capabilities. Another major benefit of a properly conducted planning effort would be to decrease the conflicts between interest groups, thus enabling the total population to work for the good of the area. If proper forethought is used in the decision making process, the area may reverse the present trend of economic decline and still maintain and even enhance its already high level of environmental and quality of life standards.

This report is not sufficiently detailed to serve as the sole basis for management decisions. The Department would, however, make one recommendation. Before any major decisions are made regarding the Basin, detailed feasibility level studies should be conducted. Costs, benefits, impacts, implications and the people's desires must be given full consideration before final, and in some cases irreversible, decisions are made.

THE EFFECTS OF MONTANA'S NEW CONSTITUTION ON SURFACE WATER RIGHTS

Subsection (1), Article IX, Section III of Montana's new Constitution, states that, "All existing rights to the use of water for any useful or beneficial purpose are hereby recognized and confirmed."

The Doctrine of Prior Appropriation is the basis of Montana's water right law. This doctrine provides for the procurement of rights to the use of surface water strictly by the application of water to beneficial use, in accordance with the procedures and limitations specified by state constitutional and statutory law or acknowledged by the courts. One characteristic feature of the doctrine is the principle of "first in time, first in right." The prior right of the earliest appropriator to the use of water is recognized to the extent of his appropriation, and each later appropriator has a similar priority with respect to all other water rights later in time than his own. The essential features of a surface water right are a diversion, a beneficial use, and the priority of the right.

Water rights in Montana (both decreed and non-decreed) are very complex and insecure. Decreed rights are subject to attack by anyone who was not a party to the water right suit (adjudication). Even the parties in the decree may be returned to court time and time again to litigate new claims and to defend their own decreed water rights. The examples of reopening of water right adjudications are too numerous to mention here, but these legal entanglements are best described by Albert Stone in his article, "Are There Any Adjudicated Streams in Montana," published in 1957.

A non-decreed right is even more vague, uncertain, and insecure and may invite adjustment by litigation. Under our present water laws, a large percentage of these non-adjudicated water rights may end up in court for a determination of their validity and priority. The adjustment of the appropriation will be based on the water needs at the time of the adjudication and the evidence presented during the suit.

Subsection (2) of Article IX, Section III, provides "The use of all water that is now or may hereafter be appropriated for sale, rent, distribution, or other beneficial use, the right-of-way over the lands of others for all ditches, drains, flumes, canals, and aqueducts necessary for collecting and storing water shall be held to be a public use." This subsection is worded almost as in the original constitutional provision, Article III, Section 15, and should not affect any of the new provisions due to the slight editing.

Subsection (3) of Article IX, Section III provides "All surface, underground, flood and atmospheric waters within the boundaries of the state are the property of the state for the use of its people and are subject to appropriation for beneficial uses as provided by law." Undoubtedly the declaration that the waters are "for the use of its people and are subject to appropriation for beneficial uses as provided by law" is intended to strengthen the existing law. Declaring that the waters are the property of the state probably has little legal effect, but it may strengthen the state's position in water right disputes with other states and the federal government.

Subsection (4) of Article IX, Section III provides "The legislature shall provide for the administration, control and regulation of water rights and shall establish a system of centralized records in addition to the present system of local records." This section seems to direct the state legislature to set up some type of administrative system regulating the acquisition and use of water rights and a centralized records system of all water rights that are valid. Exactly what type of administrative system is to be established is unclear, but the framers of our new Constitution apparently intended that the present water rights system be revamped so that our water resources can be utilized in the best manner possible and so that individual water rights are protected.

PUBLIC MEETING

A public involvement meeting was held in Ennis during the evening of November 15, 1972. The meeting was announced in both the Virginia City and Whitehall newspapers, and open invitation letters were sent to many of the civic groups active in the planning area. About eighty persons attended.

After members of the Department presented preliminary resource data, a general question and answer session was held. A questionnaire was also handed out during the meeting. A sample of the questionnaire and the tabulated results appear at the end of this report.

Several trends emerged during the tabulation process. There was a concensus among those returning the questionnaire that both federal and state involvement relating to development of recreational and irrigation facilities should be minimized. There is a strong feeling running against the current trend of private land shifting from agricultural to recreational and rural-residential use. This could be a direct result of the increasing numbers of individual home sites along the river as well as larger developments such as the Shining Mountains complex.

One of the more significant opinions that came to light through the use of the questionnaire was that 100% of the people attending the meeting felt that recreation in one form or another would increase in the Basin during the next ten to fifteen years. The majority also felt that there were inherent conflicts between agricultural and recreational uses, but that these conflicts were not severe enough to result in a mutually exclusive situation.

When those present were asked if they would be willing to participate in planning efforts taking place in the Basin, they responded affirmatively at better than a three-to-one ratio.

The opportunity exists in the Basin for a resource planning effort that could take advantage of the high recreational potential of the area while simultaneously increasing the existing agricultural base. If this type of study takes place, however, public involvement must play a large and continuous role. A primary consideration underlying the emphasis the Department places on public involvement in its planning efforts is the recognition that those affected by planning should and must have the opportunity to influence and shape those plans.

Appendix III

Occupation______________. Year-round resident of Madison County? _____YES _____NO

Years of residence in Madison County _______. Are you a landowner? ____YES _____NO

What are your feelings about Water Management and Development in Madison Valley?

Irrigation:

Efficiency of current irrigation	OK as it is	1	2	3	4	5	Should be Improved
State or Federal development of new irrigation	Strongly Against	1	2	3	4	5	Strongly For
Privately financed development on private lands	Strongly Against	1	2	3	4	5	Strongly For

Recreation:

We need more Government-owned fishing access sites and campgrounds	Strongly Disagree	1	2	3	4	5	Strongly Agree
We need more privately-owned fishing access sites and campgrounds	Strongly Disagree	1	2	3	4	5	Strongly Agree
Private land use changing from agriculture to recreational and rural-residential	Strongly Disagree	1	2	3	4	5	Strongly Agree

Other:

Conflict between recreation and agriculture in the Madison Basin	Totally Incompatible	1	2	3	4	5	No conflict at all

What problem(s) do you feel State Water Planning should concentrate on in the Madison Basin?____

____

Do you feel the Madison Resource Review Study has left out any water resource alternatives in the basin?____

____

Briefly outline what you feel is likely to take place in the Madison Basin in the next 10 - 15 years.

Agriculture____

____

Recreation____

____

Mineral Development____

____

Water Management and Development____

____

Others____

The State Water Plan will be of value only if it is done with the aid of the people. How would you be willing to participate in planning for the water resources of your area?____

____

____

(If additional space is needed for comments, please use the other side of this sheet)

QUESTIONNAIRE RESULTS - Ennis, Montana - November 15, 1972

Estimated attendance - 80

Questionnaires returned - 60

Occupation:		Year-round Residents	Landowners	Avr. Yrs. of Residence
Ranchers	32	Yes - 56	Yes - 49	Average - 28.5
Businessmen	12	No - 4	No - 9	High - 83
Students	1			Low - 2
Retired	3			
Government	7			
Housewives	4			

What are your feelings about Water Management and Development in Madison Valley?

Irrigation:

		1	2	3	4	5		Answers
Efficiency of current irrigation	OK as it is	12	5	16	2	15	Should be Improved	50
State or Federal development of new irrigation	Strongly Against	28	6	11	3	5	Strongly For	53
Privately financed development on private lands	Strongly Against	6	0	10	6	28	Strongly For	50

Recreation:

		1	2	3	4	5		Answers
We need more Government-owned fishing access sites and campgrounds	Strongly Disagree	39	2	7	3	6	Strongly Agree	57
We need more privately-owned fishing access sites and campgrounds	Strongly Disagree	19	3	15	5	15	Strongly Agree	57
Private land use changing from agriculture to recreational and rural-residential	Strongly Disagree	37	8	8	2	1	Strongly Agree	56

Other:

		1	2	3	4	5		Answers
Conflict between recreation and agriculture in the Madison Basin	Totally Incompatible	8	6	31	4	7	No conflict at all	56

What problems do you feel State Water Planning should concentrate on in the Madison Basin?

Use all waters in the Basin	9
Water pollution	5
The conflict between recreation and irrigation	5
Water for irrigation	7
Help ranchers	4
Try to balance irrigation and recreation	3
Water rights	2
Keep Government out	2
Protect Basin from recreation and developers	1
Help recreationists	1
Assign values to alternatives	1
Seek constant flows	1
Ground-water development	1
Maintain status quo	1
Increased efficiency	1
Landowners' rights	1
Planning coordination	1

Briefly outline what you feel is likely to take place in the Madison Basin in the next 10-15 years.

Agriculture Up - 13 Same - 7 Down - 18 Larger holdings - 6 Increased efficiency - 6

Recreation Up - 47 Same - 0 Down - 0

Minerals Up - 14 Same -15 Down - 2

Water Management and Development

Increasing Government control	10
Increasing use	9
Increasing efficiency	4
Improvement	4
Small watershed projects	1
Development of Ennis Lake	1
A balance between irrigation and recreation	1
Maintenance and improvement of water quality	1
Little development	1

The State Water Plan will be of value only if it is done with the aid of the people. How would you be willing to participate in planning for the water resources of your area?

Willing to help	
Any way possible	15
Public meetings	3
Join the Planning Board	2
Through local Resource Conservation and Development	1
Through local Soil Conservation Service	1
Through Farm Bureau	1
Specialized information	1
	24
Unwilling to help because	
Not knowledgeable	1
Poor (monetary)	1
Refusal	1
No problems	1
Less or no Government planning needed	3
	7